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THE DECORATIVE ART OF THE NORTH AMERICAN INDIANS.

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THE extended investigations on primitive decorative art which have been made during the last twenty years have clearly shown that almost everywhere the decorative designs used by primitive man do not serve purely esthetic ends, but that they suggest to his mind certain definite concepts. They are not only decorations, but symbols of definite ideas.

Much has been written on this subject; and for a time the opinion prevailed that wherever an ornament is explained as a representation of a certain object, its origin has been in a realistic representation of that object, and that it has gradually assumed a more and more conventionalized form, which often has developed into a purely geometrical motive.* On the other hand, Cushing and Holmes have pointed out the important influence of material and technique in the evolution of design, and, following Semper, have called attention to the frequent transfer of designs developed in one technique to another. Thus, according to Semper, forms developed in wood architecture were imitated in stone, and Cushing and Holmes showed that textile designs are imitated on pottery.

The origin of certain designs from technical forms is now recognized as an important factor, and it must therefore be assumed that in many cases the interpretation has been read into the design. The existence of this tendency has recently been pointed out by H.

* See A. C. Haddon, 'Evolution in Art.'

FIG. 1*a* ESKIMO IN ORDINARY DRESS.

Schurtz* and by Professor A. D. F. Hamlin,† who has treated in a series of essays the evolution of decorative motives.

In speaking of the process of conventionalization or degeneration of realistic motives, Professor Hamlin says: "Indeed, this degeneration may reasonably be accepted as suggesting that the geometric forms which it approaches were already in habitual use when it began, and that the direction of the degeneration was determined by a

FIG. 1*b*. SHAMANISTIC COAT OF ESKIMO.

preexisting habit or 'expectancy' (as Dr. Colley March calls it) of geometric form acquired in skeuomorphic decoration"‡ (*i. e.*, in a form developed from technical motives). At another place§ he says: "After having undergone in its own home such series of modifications, the motive becomes known to the artists of some race or

* H. Schurtz, 'Urgeschichte der Kultur,' p. 540.

† *The American Architect and Building News*, 1898.

‡ *Ibid.*, p. 93.

§ *Ibid.*, p. 35.

civilization through the agency either of commerce or of conquest. It is carried across seas and lands, and in new hands receives still another dress in combinations still more incongruous with its original significance. It is no longer a symbol, but an arbitrary ornament, wholly conventional, modified to suit the taste and the arts of the foreigners who have adopted it. In many cases it undergoes modification in two or more directions, resulting in divergent developments, which in time produce as many distinct motives—cousins, as it were, of each other—each of which runs its own course independently of the others. This phenomenon we may call 'divergence.' A common cause of divergence is the tendency to assimilate a borrowed motive to some indigenous and familiar form, usually a natural object, thus setting up a new method of treatment quite foreign to the origin of the motive."

I intend to show in the following pages that the same processes, which Professor Hamlin traces by historical evidence in the art of the civilized peoples of the old world, have occurred among the primitive tribes of North America.*

Before taking up this subject, I wish to call attention to a peculiar difference between the decorative style applied in ceremonial objects and that employed in articles of every-day use. We find a considerable number of cases which demonstrate the fact that, on the whole, the decoration of ceremonial objects is much more realistic than that of ordinary objects. Thus we find the garments for ceremonial dances of the Arapaho covered with pictographic representations of animals, their sacred pipe covered with human and other forms, while their painted blankets for ordinary wear are generally adorned with geometrical designs. Among the Thompson Indians ceremonial blankets are also covered with pictographic designs, while ordinary wearing-apparel and basketry are decorated with very simple geometrical motives. On the stem of a shaman's pipe we find a series of pictographs, while an ordinary pipe shows geometric forms. Even among the eastern Eskimo, whose decorative art, on the whole, is very rudimentary, a shamanistic coat has been found which has a number of realistic motives, while the ordinary dress of the same tribe shows no trace of such decoration (Fig. 1). Perhaps the most striking examples of this kind are the woven designs of the Huichol Indians of

* The examples and illustrations here represented are taken, unless otherwise stated, from specimens in the American Museum of Natural History. The information and material used were collected by Dr. Roland B. Dixon, Professor Livingston Farrand, Dr. A. L. Kroeber, Dr. Berthold Laufer, Dr. Carl Lumholtz, Mr. H. H. St. Clair, Mr. James Teit and Dr. Clark Wissler, all of whom have contributed to the systematic study of decorative art undertaken by the museum.

Mexico. All their ceremonial weavings are covered with more or less realistic designs, while all their ordinary wearing-apparel presents geometrical motives. In fact, the style of the two is so different that it hardly seems to belong to the same tribe (Fig. 2). The same phenomenon may be observed outside of America, as is demonstrated by the difference in style between the shaman's coat and the ordinary coat of the Gold of the Amur River (Fig. 3). We may perhaps recognize the same tendency in the style of decoration of modern dwelling-rooms and in that of public buildings. The designs on the stained glass of house-windows are usually arranged in geometrical forms; those of churches represent pictures. The wall decorations of houses are wall papers of more or less geometrical character; those of halls devoted to public uses are generally adorned with symbolic pictures.

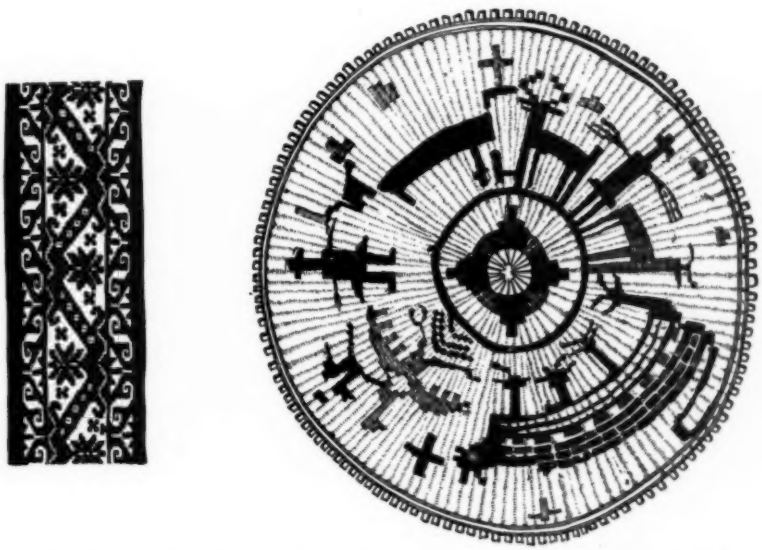


FIG. 2. WOVEN DESIGNS OF THE HUICHOL INDIANS. (After Dr. Carl Lumholtz.)

This difference in the treatment of ceremonial and common objects shows clearly that the reason for the conventionalization of motives can not be solely a technical one, for if so, it would act in one case as well as in the other. In ceremonial objects the ideas represented are more important than the decorative effect, and it is intelligible that the resistance to conventionalism may be strong; although in some cases the very sacredness of the idea represented might induce the artist to obscure his meaning intentionally, in order to keep the significance of the design from profane eyes. It may, therefore, be assumed that, if a tendency to conventionalization exists, it will manifest itself

differently, even among the same tribe, according to the preponderance of the decorative or descriptive value of the design.

On the other hand, the general prevalence of symbolic significance in ordinary decoration shows that this is an important aspect of decorative art, and a tendency to retain the realistic form might be expected, provided its origin were from realistic forms. If, therefore, the whole decorative art of some tribes shows no trace of realism, it may well be doubted whether their ordinary decorative designs were originally realistic.

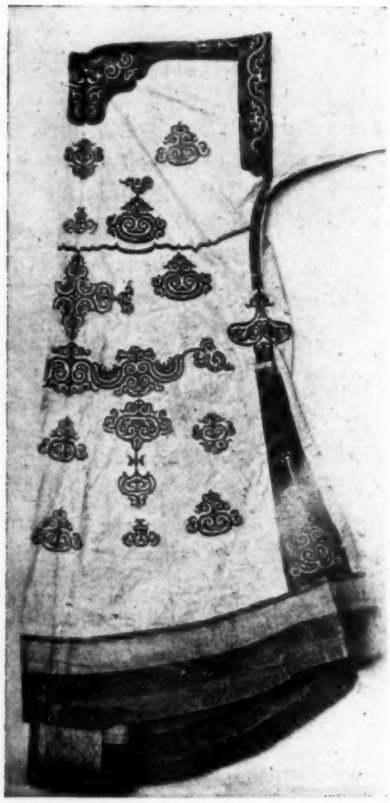


FIG. 3a. ORDINARY COAT OF THE GOLD OF THE AMUR RIVER. (After Dr. Berthold Laufer.)

The history of decorative design can best be investigated by analyzing the styles of form and interpretation prevailing over a limited area. If the style of art were entirely indigenous in a given tribe, and developed either from conventionalization of realistic designs or from the elaboration of technical motives, we should expect to find a different style and different motives in each tribe. The general customs and beliefs might be expected to determine the subjects chosen for decoration, or the ideas that are read into the technical designs.

As a matter of fact, the native art of North America shows a very different state of affairs. All over the Great Plains and in a large portion of the western plateaus an art is found which, notwithstanding local peculiarities, is of a uniform type. It is characterized by the application of colored triangles and quadrangles in both painting and embroidery in a manner which is found in no other part of the world.

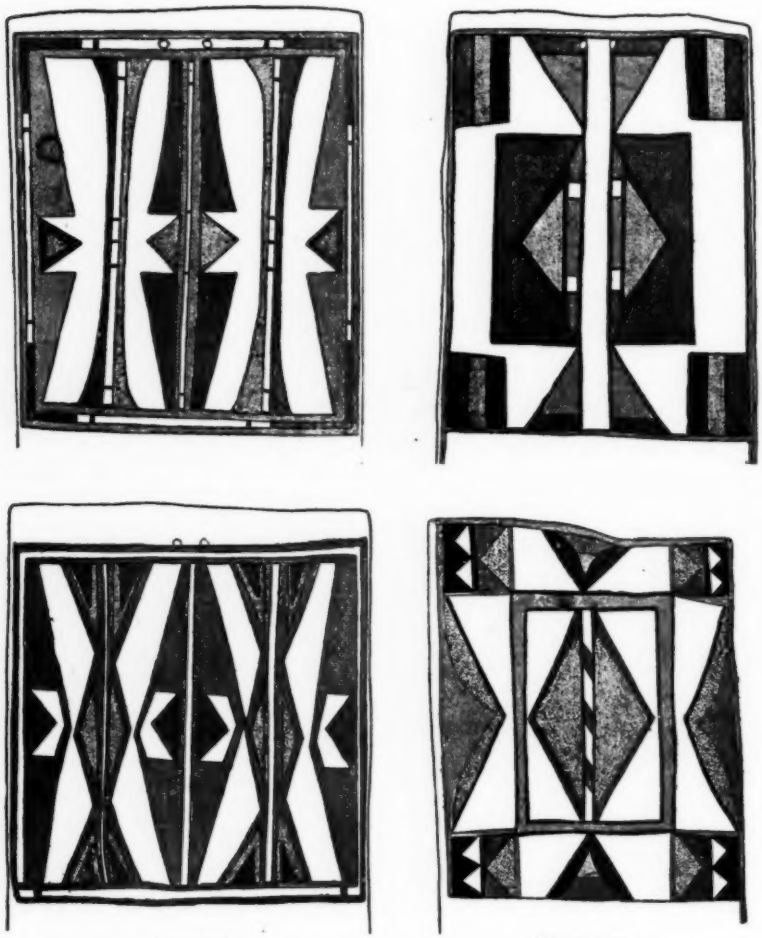
The slight differences of styles which occur are well exemplified in the style of painted rawhide bags or envelopes, the so-called 'parfleches.' Mr. St. Clair has observed that the Arapaho are in the habit of laying on the colors rather delicately, in areas of moderate size, and of following out a general arrangement of their motives in stripes; that the Shoshone, on the other hand, like large areas of

solid colors, bordered by heavy blue bands, and an arrangement in which a central field is set off rather prominently from the rest of the design (Fig. 4). This difference is so marked that it is easy to tell a Shoshone parfleche that has found its way to the Arapaho from par-

FIG. 3*b*. COAT OF A SHAMAN OF THE GOLD OF THE AMUR RIVER.

fleches of Arapaho manufacture. In other cases the most characteristic difference consists in the place on the parfleche to which the design is applied. The Arapaho and the Shoshone never decorate the sides of a bag, only its flaps, while the tribes of Idaho and Montana always decorate the sides. Another peculiarity of Arapaho parfleche-

painting, as compared to that of the Shoshone, is the predilection for two right-angled triangles standing on the same line, their right angles facing each other—a motive of common occurrence all over the southern part of the Plains and in the southwestern territories; while the Shoshone generally place these triangles with facing acute angles.



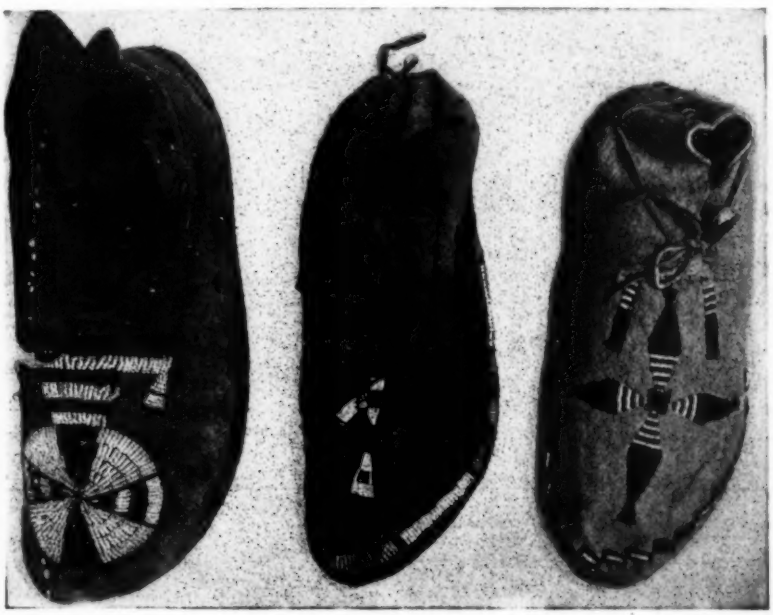
ARAPAHO. SHOSHONE.

FIG. 4. PAINTED RAWHIDE BAGS. (After A. L. Kroeber and H. H. St. Clair.)

A detailed study of the art brings out many minor differences of this sort, although the general type is very uniform.

Certain types of designs are so much alike that they might belong to one tribe as well as to another. A series of moccasins of the Shoshone, Sioux and Arapaho (Fig. 5) will serve as a good example. The characteristic forms of all of these are a cross on the uppers, con-

nected with a bar on the instep, from which arise at each end two short lines. These designs are so complex that evidently they must have had a common origin. It is of great importance to note that nevertheless the explanations given by the various tribes are quite different. The design is interpreted by the Arapaho as the morning star; the bar on the instep, as the horizon; the short lines, as the twinkling of the star. To the mind of the Sioux the design conveys the idea of feathers, when applied to a woman's moccasin; when found on a man's moccasin, it symbolizes the sacred shield suspended from tent-poles. The identical design was explained by the Shoshone



A *B* *C*

FIG. 5. MOCCASINS; *A*. SHOSHONE; *B*. SIOUX; *C*. SIOUX AND ARAPAHO.

as signifying the sun (the circle) and its rays; but also the thunder-bird, the cross-arms of the cross evidently being the wings; the part nearest the toe, the tail, and the upper part, the neck with two strongly conventionalized heads attached. If these are the ideas conveyed by this design to the weavers, it is clear that they must have developed after the invention or introduction of the design; that the design is primary, the idea secondary, and that the idea has nothing to do with the historical development of the design itself.

It may be well to give a few additional examples of such similarity of design and difference of symbolism. One of the typical designs

of this area is a cross to the ends of which deeply notched squares are attached (Fig. 6). Dr. Kroeber* received the following explanation of this design from an Arapaho: the diamond in the center represents a person; the four forked ornaments surrounding it are buffalo hoofs or tracks. Dr. Wissler found the design on a pair of woman's leggings of the Sioux. In this case the diamond-shaped center of the design represents the breast of a turtle; the green lines forming the cross indicate the four points of the compass; the forked ornaments symbolize forks of trees struck by hailstones, which are indicated by small white rectangles. Mr. St. Clair came across the same design among the Shoshone, where it was found on a cowhide bag. The central diamond was interpreted as the sun and clouds; the notched designs were explained as mountain-sheep hoofs. There is a certain similarity in this case between the explanations given by the Arapaho and those of the Shoshone, while the Sioux connect ideas of a different type with the design.

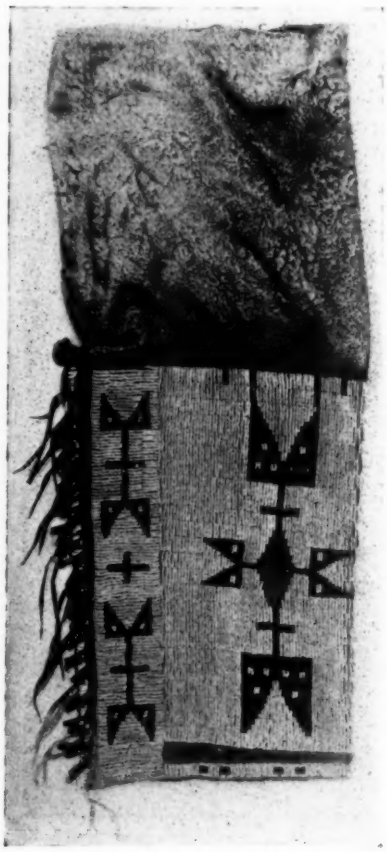


FIG. 6. LEGGING WITH BEAD EMBROIDERY.

Such differences of interpretation are also found on painted designs. The Shoshone sometimes imagine they see a battle scene in the squares and triangles of their parfleche designs. The square in the center of Fig. 7 was explained to Mr. St. Clair as an enclosure in which the enemy was kept by a besieging party, represented by the marginal squares. The narrow central line is the trail by which the enemy made good his escape. Many others represent geographical features, such as mountains and valleys. Such geographical ideas are represented on some Arapaho parfleches, while others exhibit a more complex symbolic significance. Battle scenes, however, are not found in interpretations given by the Arapaho.

* A. L. Kroeber, 'The Arapaho,' *Bulletin American Museum of Natural History*, Vol. XVIII.

The similarity of complex designs, combined with dissimilarity of interpretation, justifies a comparison of simpler forms. These might be believed to have originated independently; but the sameness of the complex forms proves that their component elements must have had a common origin, or at least have been assimilated by the same forms. One of the striking examples of this kind is the cross. Among the Arapaho it signifies almost invariably the morning star. To the mind of the Shoshone it conveys the idea of barter. The Sioux recognizes in it a man slain in battle and lying flat on the ground with arms outstretched. The Thompson Indians of British Columbia recognize in it the crossing trails at which sacrifices are made.

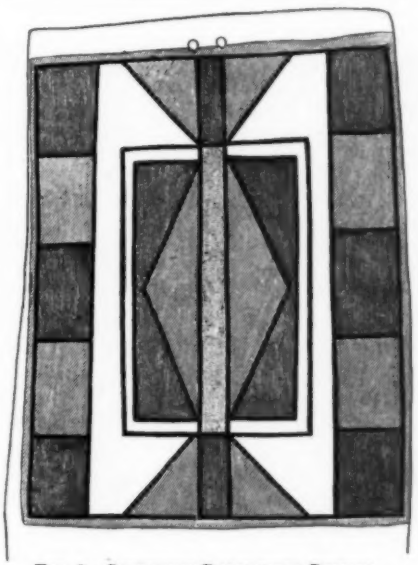


FIG. 7. SHOSHONE PARFLECHE DESIGN.

The simple straight red lines with which skin bags are decorated are another good example. A specimen was collected by Dr. Kroeber among the Arapaho (Figs. 8a and 8b) in which he explains the stripes on the beaded design on the narrow sides and on the flaps of the bag as camp-trails; the shorter transverse stripes intersecting these longitudinal lines, as ravines, that is, camping-places. On the front of the bag the horizontal lines of quill-work, which resemble the lines on buffalo-robes, are paths. Bunches of feathers on these lines represent buffalo-meat hung up to dry. Adjoining the bead-work are small tin cylinders with tufts of red hair; these represent pendants or rattles on tents. Mr. St. Clair obtained the following explanation of a Shoshone bag of almost identical design: The porcupine-quill work on the front of the bag represents horse-trails. The red horse-hair tassels at each side are horses stolen by people of one village from those of another, the villages being represented by the bead-work at the sides of the bag. The bead-work on the flap represents the owners of the horses indicated by the horse-hair tassels on the flap. Among the Sioux the same design is used in the puberty ceremonial, and symbolizes the path of life.

It must not be believed that the interpretation of a certain motive, or even of a complex figure when used by the members of one tribe,

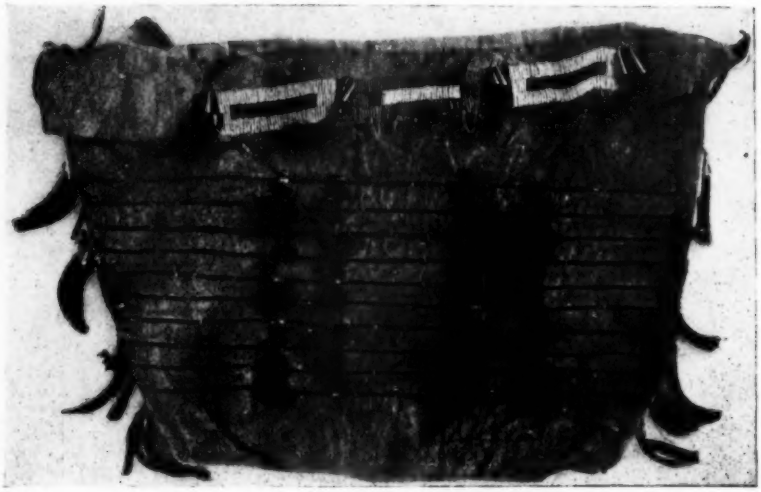


FIG. 8*a*. SKIN BAG OF THE ARAPAHO. (After A. L. Kroeber.)

is always the same. As a matter of fact, the number of ideas expressed by it is often quite varied. We find, for instance, the obtuse triangle with enclosed rectangle (Fig. 4) explained by the Arapaho as the mythic cave from which the buffalo issued, as cattle-tracks, as a mountain, cloud, brush hut and tent; an acute triangle, with small triangles attached to its base, as a bird-tail, frog, tent and bear-foot.

FIG. 8*b*. SIDE OF ARAPAHO BAG.

Nevertheless the explanations given by various tribes show peculiar characteristics in which they differ from those of other tribes. The explanations possess no less a style of their own than the art itself. Triangles are explained as tents by all the tribes, and mountains or hills form a prominent feature of their descriptions; but among the three tribes mentioned only the Sioux see wounds, battle scenes with moving masses of men, horses, the pursuit of enemies, the flight of arrows, in their conventional de-

signs; only the Shoshone see in them pictures of forts and stones piled up in memory of battles; only the Arapaho recognize in them prayers for life directed to the morning star.

We find, therefore, that in this area the same style of art is widely distributed, while the style of explanation differs materially among its various tribes.

It may be worth while to review briefly the distribution of the style of art here discussed. On the whole, it is confined to the Plains Indians, west of the eastern wooded area. It would seem that it has been carried into the plateau region rather recently, where, however,

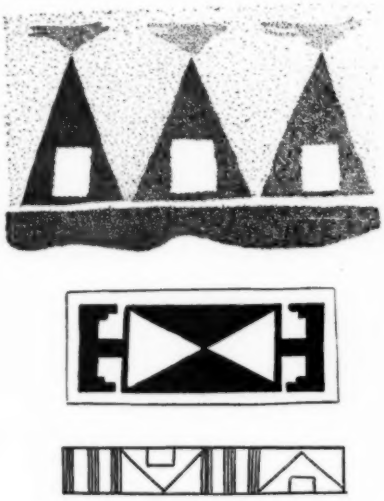


FIG. 9. DECORATIVE MOTIVES OF THE PUEBLO INDIANS. (After Dr. W. F. Fewkes.*)

FIG. 10 WOVEN BAG OF THE NEZ PERCÉS.

it has affected almost all the tribes east of the Cascade Range and of the Sierra Nevada. We find the acute triangle with small supporting triangles, and the obtuse triangle with enclosed rectangle, in the characteristic arrangement of the parfleches, on a bag of the Nez Percés (Fig. 10) collected by Dr. Livingston Farrand. At first glance, the art of the Pueblos seems quite different from the one that we are discussing here; but I believe that an intimate association of the two may be traced. The old pottery described by Dr. Fewkes, for instance, shows a number of the peculiar triangle and square motives which are so characteristic of the art of the Indians of the Plains. The same triangle with supporting lines, the same triangle with the enclosed square (Fig. 10), is found here. It seems very plain to my mind that the transfer of this art from pottery to embroidery and painting on flat surfaces has brought about the introduction of the triangular

* From specimens in the U. S. National Museum.

and rectangular forms which are the prime characteristic of this type of art.

In the prehistoric art of the northern plateaus, in California, on the North Pacific coast, in the Mackenzie Basin, in the wooded area of the Atlantic coast, we find styles of art which differ from the art of the Plains, and which have much less in common with Pueblo art. Therefore I am inclined to consider the art of the Plains Indians in many of its traits as developed from the art of the Pueblos. I think the general facts of the culture of these tribes are fairly in accord with this notion, since it would seem that the complex social and religious rites of the southwest gradually become simpler and less definite as we proceed northward. If this opinion regarding the origin of the art of the Plains is correct, we are led to the conclusion that the tent with its pegs is the same form in origin as the rain-clouds of the Pueblos, so that the scope of interpretations of the same form is still more enlarged. Under these conditions, we must conclude that the interpretation is probably secondary throughout, and has become associated with the form which was obtained by borrowing. With this we are brought face to face with the skeuomorphic origin of the triangular design from basketry motives, which has been so much discussed of recent years.

The so-called ' quail-tip ' design of California is another example of the continuous distribution of a motive over a wide area, the occurrence of which in the outlying districts must be due to borrowing. The characteristic feature of this design, which occurs in the basketry of California and Oregon, is a vertical line, suddenly turning outward at its end. This motive occurs on both twined and coiled basketry, and with many explanations.* In some combinations it is explained as the lizard's foot (Fig. 11, *a, b*), in others as the pine cone or the mountain (Fig. 11, *c*). The gradual distribution of this motive over a wide area can best be proved in this case by a comparison with the distribution of the technique in which it is applied. The design occurs all over central and northern California. On Columbia River it is found on the Klickitat baskets. These are of the peculiar imbricated basketry which is made from this point on, northward. While the designs on imbricated basketry found in British Columbia are of a peculiar character, the Klickitat baskets of the same make (Fig. 11, *d*) have the typical California designs which also occur on the twined bags of this district (Fig. 11, *e*).

Thus we find, not only that the distribution of interpretations and that of motives do not coincide, but also that the distribution of technique does not agree with that of motives. I think we can also demon-

* Roland B. Dixon, ' Basketry Designs of the Indians of Northern California,' *Bulletin American Museum of Natural History*, Vol. XVII., pp. 2 ff.

strate that the limits of styles of interpretation in some cases overlap the limits of styles of art. We have seen that on the Plains the style of art covers a wider area than the style of interpretation. It would seem that in other regions the reverse is the case. For instance, the style of art of the Nootka tribes differs very much from that of the

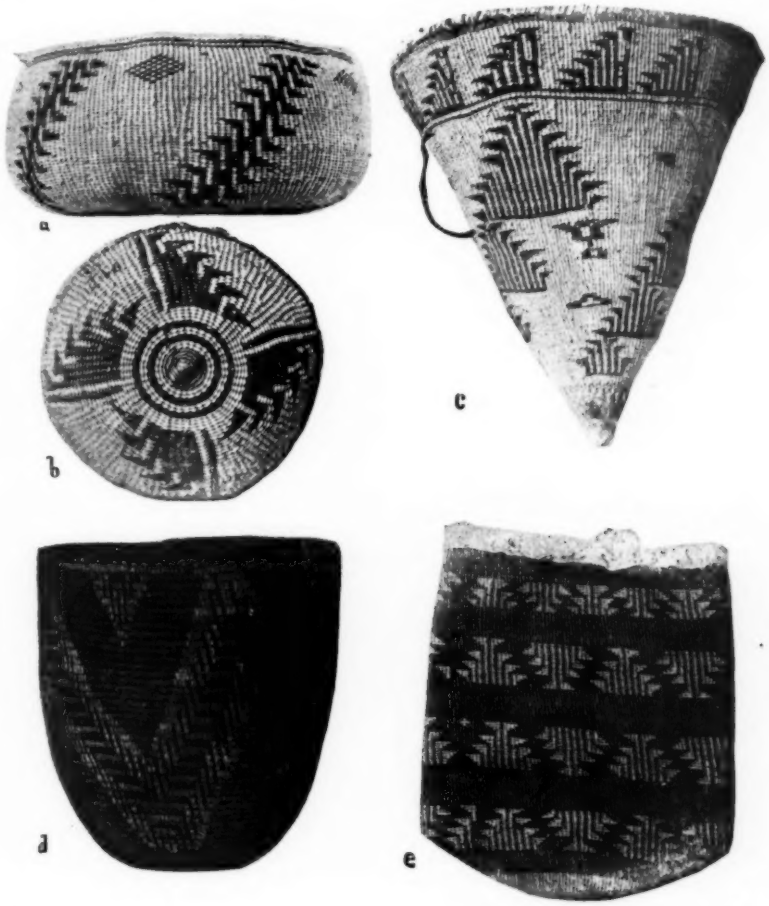


FIG. 11. BASKETS FROM THE PACIFIC COAST. *a*, *b*, PIT RIVER, CALIFORNIA; *c*, MAIDU, CALIFORNIA; *d*, KLICKITAT, WASHINGTON; *e*, NEZ PERCÉS, IDAHO. (*a*, *b* and *c* after Dr. Roland B. Dixon.)

Kwakiutl. Although both apply animal motives, the Nootka use very little surface decoration consisting of combinations of characteristic curved lines, which play an important part in Kwakiutl art, and which serve to symbolize various parts of the body. Nootka art is more realistic and at the same time cruder than Kwakiutl art. The ideas expressed in the art of both tribes, however, are practically the same. In the southwest we find that the culture of the Pueblos has

deeply influenced the neighboring Athapascan and Sonoran tribes, while at the same time the decoration of their basketry bears a close relation to that of Californian basketry. Although I do not know the interpretations of designs given by the Apache, Pima and Navajo, it seems probable that they have been influenced by the ideas current among the Pueblos. Among the Pueblos themselves—and in these I include the tribes of northern Mexico, such as the Huichol—there are well-marked local styles of technique and of decoration, and a general

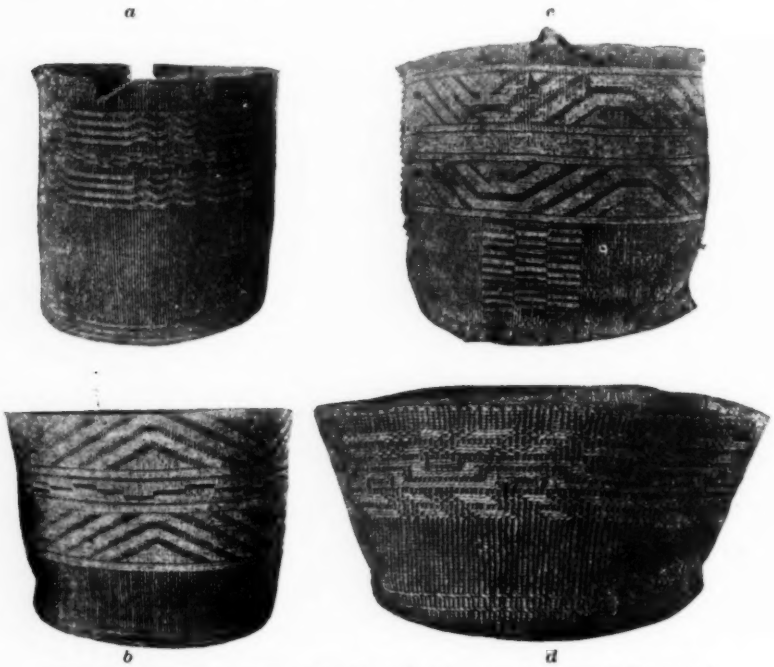


FIG. 12. TLINGIT BASKETS. (Specimens in the possession of G. T. Emmons.)

similarity of interpretation. I think the marked prevalence of geographical interpretations found among the Salish tribes of British Columbia, the Shoshone and the Arapaho is another instance of distribution of a style of interpretation over an area including divers styles of art.

In a few cases it seems almost self-evident, from a consideration of the interpretations themselves, that they can not have developed from realistic forms. The multiplicity of Arapaho explanations for the triangles which I mentioned before suggest this. According to G. T. Emmons,* the zigzag and the closely allied meander in Tlingit basketry have a variety of meanings. The zigzag may represent the

* 'The Basketry of the Tlingit,' *Memoirs American Museum of Natural History,'* Vol. III., pp. 263 ff.

tail of the land-otter (Fig. 12, *a*), the hood of the raven (Fig. 12, *b*), the butterfly (Fig. 12, *c*), or, when given a rectangular form (Fig. 12, *d*), waves and floating objects. It is evident, in view of the data here discussed, that these must be different interpretations of motives of similar origin.

We conclude from all this that the explanation of designs is secondary almost throughout and due to a late association of ideas and forms, and that as a rule a gradual transition from realistic motives to geometric forms did not take place. The two groups of phenomena—interpretation and style—appear to be independent. We may say that it is a general law that designs are considered significant. Different tribes may interpret the same style by distinct groups of ideas. On the other hand, certain groups of ideas may be spread over tribes whose decorative art follows different styles, so that the same ideas are expressed by different styles of art.

We may express this fact also by saying that the history of the artistic development of a people, and the style that they have developed at any given time, predetermine the method by which they express their ideas in decorative art; and that the type of ideas that a people is accustomed to express by means of decorative art predetermines the explanation that will be given to a new design. It would therefore seem that there are certain typical associations between ideas and forms which become established, and which are used for artistic expression. The idea which a design expresses at the present time is not necessarily a clew to its history. It seems probable that idea and style exist independently, and influence each other constantly.

For the present it remains an open question, why the tendency to form associations between certain ideas and decorative motives is so strong among all primitive people. The tendency is evidently similar to that observed among children who enjoy interpreting simple forms as objects to which the form has a slight resemblance; and this, in turn, may bear some relation to the peculiar character of realism in primitive art, to which I believe Von den Steinen* was the first to draw attention. The primitive artist does not attempt to draw what he sees, but merely combines what are to his mind the characteristic features of an object, without regard to their actual space relation in the visual image. For this reason he may also be more ready than we are to consider some characteristic feature as symbolic of an object, and thus associate forms and objects in ways that seem to us unexpected.

It may be worth while to mention one general point of view that is suggested by our remarks. The explanations of decorative design

* 'Unter den Natur-völkern Central-Brasiliens,' pp. 250 ff.

given by the native suggest that to his mind the form of the design is a result of attempts to represent by means of decorative art a certain idea. We have seen that this can not be the true history of the design, but that it probably originated in an entirely different manner. What is true in the case of decorative art is true of other ethnic phenomena. The historical explanation of customs given by the native is generally a result of speculation, not by any means a true historical explanation. The mythical explanation of rites and customs is seldom of historical value, but is generally due to associations formed in the course of events, while the early history of myths and rite must be looked for in entirely different causes, and interpreted by different methods. Native explanations of laws, of the origin of the form of society, must have developed in the same manner, and therefore can not give any clew in regard to historical events, while the association of ideas of which they are the expression furnishes most valuable psychological material.

HIGHWAYS AND BYWAYS OF ANIMAL LIFE.

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No matter what particular theory he may hold as to the origin and distribution of life over this globe of ours, the thoughtful naturalist or the thoughtful student in any sphere of research, if he stops to question at all, must ponder with deepest interest the problems connected with the wide dispersal of animal life and its adaptations to most diverse conditions. From darkest depths of abyssal ocean to lofty mountain peak, life abounds and even the high regions of ethereal air are traversed by one or another of the organisms which represent the great aggregate of animal life.

It is true that these limits, viewed from a certain standpoint, are very narrow, for a moment's consideration will reveal the fact that life on this sphere now, as in all time past, is confined to a comparatively thin stratum at its surface. From the deepest habitable reaches of ocean to the highest point attainable by bird (a few miles, indeed, of vertical elevation) is a slight range in the radius of the earth, and the densely populated stratum of land and sea—the stratum actually capable of supporting life continuously is, in reality, limited to a very few feet—an exceedingly thin layer on a gigantic ball. One almost trembles at the thought of how narrow the habitable limits and how slight a change in conditions of atmospheric or other physical environment might extinguish the vital spark which has characterized mother earth through untold stretches of years. Consider a moment how little below the surface any animal can live, how slightly above it is existence possible.

But my purpose here is to touch upon some of the routes of development of the shifting forms of animal life which have drifted hither and thither over sea and land in the great struggle for perpetuity and expansion.

This effort we can clearly see in the movement taking place under our own eyes, and, more largely, within historic times, as evidenced by the host of animals introduced and spread in the new world from the old, the displacement or extinction of certain forms and perhaps most emphatically in man himself, the dominant animal of the present age, whose struggle has now become not so much a struggle with other species as a struggle for dominance of race over race, or nation

over nation. Glancing backward, however, over that long and varied line of animal life shown to us in fossil forms—their history incontestably preserved for us direct from the hand of creation, we must readjust our vision, enlarge our horizon to grasp the significance of the origin, distribution, adaptation and survival of life. Life is here—life has been a feature of this old earth's history through countless ages. Whence came it, what have been the paths it has followed in its development and adaptation to the varied conditions of earth, sea, land and air? It would be presumption too gross to admit of toleration to assume to fully discuss so extensive a problem within the limits of a magazine article, but an effort will be made to point out in a rapid survey some of the factors that seem to have been effective in the peopling of the earth.

First, we should observe the conditions that have existed and that had to be met in the growth of organic beings—for we should not forget that life has had to adjust itself to conditions that existed prior to its appearance, since the conditions have not been modified to accommodate its needs.

Stretches of water and great reaches of land and the atmosphere furnish the basis upon which organisms must act, and either water or air, the medium that must serve them for many of their most vital functions. Glancing over the opportunities for survival of life in a delicate, simple condition, we can hardly fail to recognize the water as the most natural element for primal life-forms. Indeed, I think no naturalist will hesitate to consider water or, at least, an extremely moist location as the necessary condition for the beginning of life. Moreover, any serious consideration of the question must force the conviction that life-forms in other less favorable locations must have reached such location by gradual modification and adaptation. For instance, we can hardly conceive of the peopling of an arid desert-region with forms such as lizards, snakes, horned toads, scorpions, beetles, etc., except by the gradual encroachment upon desert area from adjacent territory by animals which were able to adapt themselves to desert conditions. Or, to put it in another form, the change to desert conditions in previously watered area must be accompanied by the driving out or extinction of all animals unable to adjust themselves to the new conditions. Assuming, then, a primary aquatic habitat for animal life, it becomes of interest to inquire both as to the most probable point of origin and as to the direction of adaptations.

While some naturalists argue for a pelagic origin of the simplest organisms, others hold to the idea of an origin near the shore, but in either case we have evident lines of travel from such a point to occupy the surrounding space. Thus from a near shore location life might work itself shoreward, adapting itself to the variable conditions of ebb

and flow of water and exposing itself to such variations of conditions as might lead to fresh-water existence—to life on the land and thence to air, and, on the other hand, a dispersal on the surface to pelagic life. Again from shore-life or the original near-shore location, there might be a contingent working into deeper seas, and still further to occupation of abyssal depths. Transfers from surface to sea bottom, and the reverse, seem probable, in fact certain, for some groups and movements of terrestrial groups of animals into water must certainly have taken place. The peopling of all habitable corners of the earth then has been a process of continual pushing out from original centers, a constant, if unconscious, effort of animal life as a whole to occupy all available space, to crowd the energy of vital force to the end of every open channel, to follow every thoroughfare and explore every by-path that might lead to nook or corner in the universe that could give support in any fashion. But seldom has any form of life started alone on its travels, and hence the crowding for place, the 'pussy wants a corner' need, the eternal jostling to get and keep that corner and its opportunities, the 'struggle for existence' that has been the dominant principle of life from the dawn of its creation. Clearly those forms most successful in adaptation to new conditions must be those that win in the race and which soonest give rise to a higher and more complex form of existence. Whether life began in a single organism the parent form for all the mighty train that followed until now, or whether numerous organisms started independently, we can hardly doubt that all were equally simple, and similar courses of modification must have affected all. Moreover, in every case, we are warranted in assuming that for all higher types of animals there was a probably common ancestral form, and distribution over the earth must have been accomplished from an initial center by succeeding generations. Further, that for each particular subordinate group, family, genus or species that now has extended distribution, we must assume dispersal from the original home of the ancestral form.

First, then, we had only aquatic life, and this element may have been densely peopled before an effort was made to move ashore or to seek dry land. All geological evidence shows enormous development of aquatic life in early times, but obviously such forms were most likely to be preserved. Land life may have been forced by the drying up of stretches of water as well as voluntary migration. But what an important change that from aquatic to terrestrial life—from water-breathing to air-breathing! What possibilities of expansion, growth and occupation in the new, untrodden sphere, in the valleys and hills of earth and in the invigorating supply of air! Up this highway have come not a few of the great groups of animals. Some of the simplest protozoans even discovered the track, and worms of various kinds have crawled to

wider or sometimes to narrower possibilities. Mollusks took advantage of the path, and many of them have reached even to life arboreal, while some, apparently disheartened or diverted by seductive opportunities, have gone back to water, still retaining, however, their air-breathing organs to prove the roundabout course of their travels.

The ancestral forms of insects doubtless followed the same broad way, but so remote are these ancestors that we may best consider the insects as primitively air-breathing. Some indeed are now aquatic, but still air-breathers, and I doubt not have taken to aquatic life as a fairly modern accomplishment. Vertebrates, however, give us the greatest advance, for from the gilled fish, and early amphibian, to bird or mammal is a long and striking course. If any branch of animals is to be thought of as having had its origin on land rather than in water, it must be the insects, that is, the immediate ancestral form to all the groups of insects. Following back their ancestral line still further we should doubtless reach an aquatic animal, but one not to be recognized as in any degree insect-like in character.

But life in the open air has not confined itself to particular places or conditions. The pressure to occupy each niche of available territory is as strong here as in the water. Here too we may trace certain well-worn paths—paths that have been common to more than one group of animals and traveled independently by each. Let us mention some —subterranean, aquatic, terrestrial, arboreal, aerial. How many forms in hosts of different groups have buried themselves more or less completely in mother earth and there found, or made for themselves, all the necessary conditions for successful life. Earthworms, crustaceans, insects too numerous to mention, mollusks and, among vertebrates, frogs, snakes, lizards, turtles, birds, moles, beavers, gophers, groundhogs, badgers, etc. This for the general trend, many of these, however, taking peculiar and tortuous by-paths to reach the end desired. From terrestrial back to aquatic life has been so frequent a course that we can hardly call the road exceptional. So many insects of different groups have become aquatic in either adult or larval life that it was long held that the insects in general were derived from these aquatic groups. None, I think it safe to say, has had such an immediate ancestry, while aquatic beetles, bugs, caterpillars and even dragonflies, caddiceflies, etc., have, I firmly believe, gradually assumed aquatic habits as descendants of forms that lived on land.

We can easily believe that frogs advanced from an aquatic to a terrestrial condition, because we can actually see the process in the individual history of each, but there is reason to believe that even among certain batrachians aquatic life becomes more habitual and succeeds a terrestrial stage. Even the frog himself becomes decidedly aquatic in his old age, and for reptiles, while we often think of them as aquatic,

especially such forms as the alligator and crocodile and the ancient marine saurians, in reality we should think of them as primarily land-inhabiting animals, some of which have gradually taken to aquatic life and in the course of time become more and more confined to a watery sphere. Aquatic turtles show this most decidedly, an extreme being found in the soft-shelled turtle, which is not only a constant resident in water, but has become possessed of special organs for respiration in water, so that air-breathing is scarcely necessary. Birds that live in the water have taken the same convenient highway, and many of them have traveled it from the time of their toothed ancestors down to the present. Penguins have gone so far along this road that their wings can no longer serve for flight, while loons and grebes and auks are on the way. Gulls, albatrosses and petrels may go far out o'er billowy wave hundreds of miles from land. Ducks and geese and swans have struck the trail, and snipe, stork and heron, crane and flamingo have rolled up their trousers and are wading in. Even the fish-hawk, the osprey and the eagle find it worth while to look beneath the wave.

The aquatic habits of the beaver furnish a most remarkable example of this, and if we could trace his acquisition of this habit from the time when he must have been an ordinary terrestrial rodent with neither a paddle-tail nor a web foot, we should certainly find an interesting career. The musk-rat has not gone so far and can not reach the same goal, as he has flattened his tail in the wrong direction.

The whale—that giant of the seas—largest of mammals and indeed of all animals, has out-traveled all his relatives in reaching out into the great ocean, but we can not possibly conceive the whale to have come from any other source or to have other ancestor than a land-inhabiting mammal. We get glimpses of the mile posts he has passed in the structures shown by the manatee, the walrus, the sea lions and others. Not that these constitute in any sense his ancestral line, for that was far back in time and so far largely a lost history. But along such stages we must believe his ancestors to have passed. The manatee in its way is as strictly aquatic as the whale but hugs the shore or river mouths.

The hippopotamus is well on the way, and I would digress here to call attention to the remarkable similarity in adaptation of the sense organs of this animal to those of the alligator and crocodile. Note that the eyes, ears and nostrils are almost exactly in the same plane and so situated that they may all be above the surface of the water, while practically no part of the head or body may be visible, an admirable adjustment to avoid detection from foes or for protection against flies, mosquitoes, etc. Seals, walruses, sea lions, sea otters and, in less degree, the polar bear, the common otter and mink, all show aquatic habit fixed or growing, and even the small boy at his favorite swim-

ming hole presents a tendency to fall into the well-worn path that leads down to amphibious quarters.

On the broad highway of terrestrial life the effort and adaptation has been to develop speed, strength, protective coverings, colors, etc., and here has been the widest and strongest struggle for supremacy that the world has witnessed. The contest for domination between the giants of old ocean—of sharks and devil-fishes, and saurians and whales, pales into insignificance compared with the battle waged between the huge terrestrial reptiles, birds, elephants, mastodons, horses, lions and man which has raged on *terra firma*. From this have come perfection of speed to one—power and energy to another, but, above all, intelligence and the dominance of brain. Out of this highway, too, run numerous and devious by-paths, the following of which furnishes us with a host of strange and fanciful creations—adaptations to extremes of heat and cold, moisture and dryness, latitude and altitude, plain and forest.

But, not content with solid earth, animal life finds its way upward into vegetation of various kinds and particularly in tree growth, reaches adaptations which become so fixed that life elsewhere would be an impossibility. This is especially marked in the great tangle of tropical forests. In these the animal life of the tree tops assumes a most pronounced character, which can scarcely be appreciated by one familiar only with lesser forests of temperate regions. Pictures fail to show the real density, for pictures must show the breaks and gaps to show at all. But perhaps the most dominant thought in the presence of such forest life is the superabundance of life, life everywhere, under every scrap of loose bark, every tuft of grass, on branch, and twig and leaf. In my despair of giving an adequate idea of this tropical tangle, I turn to an article in *Harper's Magazine* by Lafcadio Hearn on a midsummer trip to the West Indies, in which he quotes from DeRafz:

> When your eyes grow weary—if it is indeed possible for them to weary of contemplating the exterior of these tremendous woods, try to penetrate a little way into their interior. What an inextricable chaos it is! The sands of the sea are not more closely pressed together than the trees are here—some straight, some curved, some upright, some toppling, falling, or leaning against one another, or heaped high upon each other. Climbing lianas, which cross from one tree to the other, like ropes passing from mast to mast, help to fill up the gaps in this treillage; and parasites—not timid parasites like ivy or moss, but parasites that are grafted upon trees—dominate the primitive trunk, overwhelm them, usurp the place of their foliage and fall back upon the soil forming factitious weeping willows. You do not find here as in the great forests of the north, the eternal monotony of beech and fir; this is the kingdom of infinite variety—species, the most diverse, elbow each other, interlace, strangle each other and down them. All ranks and orders are confounded as in a human mob.

As for the soil it is needless to think of looking at it; it lies as far below us as the bottom of the sea; it disappeared ever so long ago, under the heaping of débris, under a sort of manure that has been accumulating there since creation; you sink into it as into slime; you walk upon petrified trunks in a dust that has no name. Here indeed it is that one can get some comprehension of what vegetable decrepitude signifies; a lurid light—as wan at noon as the light of the moon at midnight, confounds forms and lends them a vague and fantastic aspect; a mephitic humidity exhales from all parts; an odor of death prevails; and a calm which is not silence (for the ear fancies it can hear the great movements of composition and decomposition perpetually going on within) tends to inspire you with the old mysterious horror which the ancients felt in the primitive forests of Germany and Gaul.

Hearn adds:

But the sense of awe inspired by the view of a tropical forest is unutterably greater than any mystical fear which any wooded wilderness of the north could ever have inspired. The very brilliancy of these colors—that seem preternatural to northern eyes—is terrifying; but the vastness of the mile-broad and mile-high masses of frondage, their impenetrability, the violet blackness of the few rare apertures in their perpendicular façades where mountain torrents break through to the sun, and their enormous murmurs, made up of a million crawling, creeping, crumbling sounds—all combine to produce the conception of a creative force that appalls. Man feels here like an insect, fears like an insect ever on the alert for merciless enemies. To enter these green abysses without a guide were madness; even with the best of guides it is perilous. Nature is dangerous here; the powers that build here are also the powers that putrefy. Here life and death are perpetually interchanging office in the never-ceasing transformation of force, melting down and reshaping living substances simultaneously within the same awful crucible. There are trees distilling venom; there are plants that have fangs; there are perfumes that affect the brain; there are cold green creepers whose touch consumes the flesh like fire, while in all the recesses and the shadows is a swarming of unfamiliar life, beautiful or hideous, insect, reptile, bird, interwarring, drowning, devouring, preying. Strange spiders of burning colors, immense lizards, scaribs cuirassed in all tints of metal, humming-birds plumaged in all splendor of jeweled radiance, flies that flash like fire, centipedes of gigantic growth. And the lord of all these, the despot of these vast domains is the terrible **Fer de lance**. . . .

Here, then, is unlimited food, abundant moisture, warmth and light, and no wonder animal life has grown apace, multiplied and modified its form—and adapted itself to forest conditions.

Along this forest route come certain strange, peculiar molluscs, which far from the native haunts of their allies have succeeded in establishing themselves in apparently successful occupation against more active forms. Insects, unnumbered, occupying every part from solid wood of the tree heart to outermost bark or leaf, a few fishes even leave their water haunts for temporary quarters up a tree, and frogs are here to stay, while snakes, lizards, chameleons, are at home awaiting callers. To birds the trees become a most natural harbor and home to rest, to nest, to eat and die. Ungainly sloths, helpless elsewhere,

are at home in the tree tops; and squirrels, opossums, coons, bears, cats, monkeys, apes, and sometimes man, find up among the branches of a tree the situation that meets pleasure or necessity.

Launching out into the air, the most difficult path to take, most hazardous and most perilous, but attempted by many different kinds of animals, is another highway. Some faint suggestion of an effort to utilize the air in locomotion is shown by the wind-blown Portuguese man-of-war, and more fully by the aeronautic spider who launches his balloon of silk for aerial flight, but no real success as traveler of the air is found until we reach the group of insects, where wings—true aerial organs of locomotion—become a conspicuous characteristic of the group. How well they have succeeded is testified by the fact that such locomotion has been in vogue with them since early paleozoic time, and, considering their size, the speed and endurance exhibited in air is equaled by no other kind of animal.

The flying-fish, driven from its native element by pursuing foe to temporary elevation in the air, is a strange abortive attempt to reach this goal, but it has taken too direct a course ever to succeed. It should have first become an air-breathing land animal before attempting the soaring act. The frogs and lizards with expanded feet for floating on the air are poor apologies for flying animals, but given time might reach that goal were not the field so fully occupied by more dominant forms. The ancient flying reptiles, known only by their fossils, reached a high degree of efficiency, if we may judge by the expanse of wing they show. In their time they were doubtless the dominant types of the air, but they left no legacy to later forms, for the wings of modern groups are formed on different plans and must have been developed *de novo* or regardless of the reptilian type.

So now we reach the birds—the truest, most perfect of aerial forms, the animals which, with natural organs, have come nearest to annihilating time and space—whose skill in traversing the trackless regions of aerial waste has been the constant envy of man, from early time down to Darius Green, Maxim and Langley and a host of modern inventors. 'O had I wings' in various refrains has been the lament of man till we may expect ere long that the want will be practically supplied. Some birds indeed do not seem to appreciate this gift and have sacrificed these organs to adapt themselves to water or to a speedy gait on land, but flight is the dominant mode of locomotion for the group. Some of the mammals, aside from man, have attempted to follow the lead of the birds and the bats have succeeded so well that they are practically cut off from all other modes of locomotion, while flying phalangers, flying squirrels, and others attest the effort in various groups to adopt this rapid though hazardous kind of locomotion.

Special Adaptations.

Along such general lines, such open roads as these, animal life has progressed, and without such limitations as to prevent further progress or adaptations to new conditions. But I wish now particularly to call attention to certain adaptations that result in a definite limitation of the animal, a fitness to special conditions and a fitness so complete that existence under other conditions is impossible, or to put it still more broadly, a return adaptation is probably impossible. Such lines of adaptation may be looked upon as by-paths or blind alleys sought out by certain forms as presenting easier conditions for existence or into which feeble species may be crowded by the force of stronger ones. Places where certain shifts provide adequate chance for survival, albeit on a lowly plane.

Such by-paths are innumerable—almost as the nooks and crannies into which organisms may crowd—and to catalogue them would be to survey a large field of zoology. They are especially interesting and instructive as showing in most emphatic manner the factors that have been operative in modifying structure and attesting the general fact of evolution. The animals that are sedentary, domestic, subterranean, parasitic; the inhabitants of caves, deserts, manufactured products, oil, vinegar, hot springs, snow and ice, on islands, under bark, in deep sea, are illustrations of such erratic departures from normal habits. While we can review but few, these few may serve to illustrate the principles involved and some may be grouped under general heads.

Perhaps the least departure from normal, free-living conditions is presented by those animals which assume a sedentary habit. This may range all the way from a temporary anchorage in mud or on a rock to permanent attachment with most fundamental changes in form and structure of the organism. It is exhibited in some degree by almost every group of animals, and were it not that its tendency is toward limitation and restriction of powers we might look upon it as one of the main avenues of development. For minute forms the attached bell animalcules, stentors, etc., are good examples, and in sponges we find this habit of fixture a constant feature and associated with marked inferiority in symmetry and activity. Hydroids, and especially corals, show it strongly developed, though the former often present free living stages alternately with the fixed. Some worms and mollusks have assumed the rôle and it was the rule with echinoderms in early time, though modern forms have largely broken away from it, not, however, until their whole symmetry had been impressed by the results of their position. The barnacles among crustacea have gone farthest in this direction, and their symmetry and structure have been so strongly influenced that it is not strange that earlier naturalists failed to suspect

their true relationship. Mollusks, like the oyster, have also been much modified by fixation, and among insects the remarkable scale insects present extreme results in this direction. It is not mere chance that the oyster and the oyster shell bark louse have similar shape. They have both been modified, quite independently and in different locations, by the same controlling factors working on a sedentary organism. Many other insects in one stage or another illustrate this phase, but space forbids their mention.

Tunicates have traveled this road and thereby lost the rich inheritance that was theirs had they cultivated their backbone instead of allowing it to pass into 'innocuous desuetude.' Even among vertebrates we see some tendency to adopt the tied-up plan, for among the fishes the lampreys attach themselves to other fishes, the remours to the belly of the shark, the sea horse temporarily fastens to branches of coral by wrapping around them his flexible tail, the flounder rests almost fixedly at certain points, but throughout the group there is practically no permanent fixity with the degeneration it entails. It will be seen by those familiar with the forms cited that the mere fact of an animal having become habitually attached in a certain place and having lost its power of free movement has greatly affected its structure and future possibilities. It has bettered its chances for survival, but it has sacrificed all hope of progressive development. I believe it is quite safe to say that no high type of animal life can be referred in its origin to a sedentary ancestry.

Another frequent by-path is that of parasitism, and, indeed, so common is this mode of life, so prevalent in some degree or other among animals of almost every branch, that it would appear to be one of the easiest roads to travel. But this road leads inevitably to restriction of freedom and limitation of sphere—often to degeneration of some portion of the organism. Its ultimate end is extreme limitation and probable extinction. Protozoans, coelenterates, worms in great numbers, crustaceans, insects, mollusks and even some remarkable vertebrates have followed this road, and in every case where the habit has gone to any great extent it would seem impossible for them to retrace the route. Wherever the parasite has become limited to a single host or to alternate hosts, destruction of the host form means death to the parasite, and extinction of the host would mean extinction of the parasite. Loss of wings in formerly winged forms, loss of eyes and other organs of sense, loss of nervous system, loss of motion, loss of digestive organ even, in extreme cases, are the penalty they pay. 'Sans eyes, sans ears, sans nose, sans mouth, sans everything,' but actual necessities of existence and reproduction.

At first thought it may not seem so strange that wastes of desert land should present no small degree of living activity, but if we notice

the conditions more carefully, we shall see that we must provide not only for the survival of the individual, but for succeeding generations of individuals, and, when we take into account the special adaptations that become necessary to permit of the development of eggs and the early stages of the different forms, it will be seen that the problem becomes much more difficult. As already hinted we can scarcely conceive of life originating under such unfavorable conditions, but must think of it as having gradually extended its range from adjacent, more habitable regions. We can see, too, that the special adaptation in this direction distinctly unfits the animal for a return to a more humid condition and, if its desert conditions were withdrawn, the probability is that it would succumb to the pressure of more active forms of life. In fact we may gather that desert forms have reached such situations as an effort to escape from the more rigid contest in regions more densely habited.

Many tribes of men have thus pushed out into arid territory, adjusting themselves as well as possible to the conditions, but always with a struggle against these special conditions that can be scarcely less severe than the struggle against stronger individuals or races that have attempted their subjugation or extermination.

Aquatic forms we may expect to be absent and still some such aquatic forms as may develop very rapidly in temporary pools of water and are otherwise adapted to long periods of desiccation have solved this problem. Birds and insects may by their ready locomotion easily take to temporary quarters under desert conditions, and some of them become fixed inhabitants, but usually with some degree of subterranean habit to protect themselves from the severity of the sun's rays, thus burrowing owls and many subterranean or nocturnal insects are characteristic of desert life. Burrowing squirrels, prairie dogs, snakes, lizards, etc., all follow the same line.

Another distinct line of adaptation is shown in the animal life inhabiting caves, a fauna so characteristic and so strikingly similar in different parts of the earth, though common origin is out of the question. Such life might be looked upon as an extreme of subterranean forms living near the surface of the ground, but there are different conditions to be met, and the results are in many cases widely different. Loss of eyes would seem to be the most frequent and, indeed, almost the first effect of such adaptation, and this modification alone would practically preclude such animals from ever attaining a successful hold upon ordinary conditions. Return to conditions of light would expose them mercilessly to the attacks of animals with ordinary organs of vision. Blind fishes, blind insects, blind crustaceans, all attest to the controlling influence of environment, and whether the animals found in these locations have come there by choice to secure cer-

tain favorable attractive conditions, to escape more dominant forms outside, or simply by chance, from being carried in streams of water into these subterranean cavities, the result has been the same for all, and their return to the struggle carried on by their ancestors out of the question. They are distinct species modified and adapted to this particular environment where survival is possible, but opportunity for progressive evolution too limited to permit of advance.

Along the path of protective devices, mimicry, adaptive coloration, form and habit have traveled a host of different forms—flies that look like bumblebees and thereby gain entrance to their nests to provide extra food for their larvæ; butterflies that look like leaves of trees; leaf insects (phasmids) so like the leaves they live upon as to be invisible to foes; bugs that look like ants; scale insects that look like excrescences on the bark of the trees they infest; edible species that have taken form and color of inedible species; toads that look like lumps of earth; frogs that look like green scum or leaf at water side; snakes and lizards in great numbers that resemble the soil on which they live; birds that so closely imitate the colors of earth, foliage or irregularities of bark as to escape observation—in fact, an unending train in varying degrees, furnishing a most fascinating field for study.

Among aquatic animals we have fishes that hug close to the bottom and acquire color and pattern which admirably protect them, and the flounder has even gone to such an extreme in this direction as to have one of its eyes transferred from its normal position to the opposite side of the head. Skates and rays have the same flattening, but retain their normal position. Other fishes resemble rocks and so perfectly as to be practically invisible. Others, like sea horses, resemble parts of sea weed, streaming in the currents of water or branches of coral to which they cling. Mollusks and crustaceans adopt this plan to make themselves inconspicuous, and the different devices shown would fill a volume. Perhaps no stranger combination is presented than in the little crab which makes its home in a mollusk shell, but not content with this protection conspires with a sea anemone to take root upon its house top and add the variety of its structure to the deception. A queer sight these anemones, nodding here and there as borne by a hidden crab.

Most animals aside from man have been content to let electricity alone, and we are inclined to think the use of this magical force in nature of very recent origin. However, some of the aquatic animals, at least, and these forms that must have had their origin in the long, long ago of geological time, have brought to their use this elusive force and present in the structure of their organs for the generation of electricity some quite remarkable parallels to the electric apparatus of human invention. In such lines we have the torpedo, a broad, flat,

peculiarly spotted form common to the Mediterranean and adjacent seas capable of liberating a charge that will shock man and must be destructive to hosts of smaller animals, upon which it is doubtless used as a means of offense and defense; in the electric siluroid of Africa, which in different structure possesses the same power in greater force, and still more pronouncedly in the electric eel of South America, the shock from which is sufficient to paralyze a horse. What strange combination of circumstances has conspired to develop such a power in these animals? Evidently some condition common to their several environments, as it must have originated independently in each of the examples cited. The difference in position and structure, though all are modified from muscular tissue, is such that no common origin can be assigned to the structure in the different forms.

In the adaptations to deep sea life we have one of the greatest extremes and, since we have here one of the most remarkable series of animals and moreover one which until recent years has been unknown to science, it will not be amiss to give it more than passing notice. In the greater depths of the ocean we have conditions rivaling those of caves in the absolute exclusion of light, but very different in the medium and in the enormous pressures to which the animals are here subjected—pressures so great that when deep sea animals are brought to the surface there is an expansion of all the soft parts, an extrusion of the eyes, stomach, etc., producing most monstrous looking forms. But the passage from moderate depths to deeper and deeper points and, finally, to the abysses of mid-ocean are gradual, and we can conceive a gradual pushing off to deeper and deeper points till enormous depths are reached. Even yet, however, it is believed that the deepest reaches are uninhabited and uninhabitable, the lowest points from which life forms have been secured being far above the extreme depths that are known.

The wonderful discoveries of the 'Challenger,' 'Albatross,' 'Blake' and other deep-sea explorations, adding a new chapter in science and whole new groups of animals hitherto unsuspected, are yet so fresh in the minds of those interested in such matters that they may well serve my purpose in illustrating those special adaptations reached by animals that have pushed into apparently inhospitable regions. The passage in this case has, however, been slow. We need assume no sudden change of physical conditions tending to produce modifications of structure, but practically unaltered physical conditions and a simply crowded condition of life forms in regions already occupied, as the main factor in pushing into this *hinterland* of habitable zones. Here as in caves we should expect the loss of light to result in the loss of eyes, but this is not always the case, for in some of these grotesque denizens of the deep instead of the loss of eyes we find the development of marvelous

phosphorescent organs which serve as a lamp to light the pathway of these strange creatures in their strange surroundings. Such adaptations can hardly be conceived as possible, save with the very gradual shifting from lighter to darker regions through the lapse of thousands and thousands of years.

In modern times, since man's domination began, another factor has appeared, and its influence in modifying animal forms and structure has been one of the most potent and striking for such as have fallen within its scope. While man's effort has been largely to exterminate the lower forms of life, especially those inimical to his interest, he has utilized others for his service, and in the process of domestication we may see compressed into brief time such changes as under natural conditions would have occupied untold years, if, indeed, they would ever have been possible, since many of these changes unfit the forms for survival under natural conditions. So potent this factor that the immortal Darwin used its results as furnishing some of the most conclusive testimony for the theory of natural selection, believing that what could be accomplished in brief time by artificial, or human, selection could be accomplished in greater time by natural selection.

To see the power of this factor we may compare the various breeds of cattle and refer all to the primitive form from which we have absolute historic evidence that they were derived. The breeds of horses are equally striking, as the immense draft horse, the Shetland pony, the thoroughbred racer and the Arabian with hosts of special strains will attest. So, too, with dogs, cats and fowls. The pigeon which furnished Darwin with so much evidence since the native rock pigeon, the extreme breeds of fantails, carriers, etc., can be seen side by side and their relationship unquestionably fixed. Now I wish particularly to call attention to the fact that many of these domesticated forms, as a result of their domestication, have been unfitted for life in other spheres, and if dropped from the fostering care of man would almost certainly suffer rapid extermination, those surviving being the ones that had been least affected by the process of domestication. A modern hog would stand a poor show, but the southern razor-back doubtless would survive, for a considerable period at least, without man's assistance. Here then is a by-path opened in very recent time and into which certain animals have been driven by man, seldom of their own choice, if ever, the confines of which have profoundly modified many and behind them the gates have been closed never to be opened again.

Pushing away from the congenial temperatures of equatorial and temperate regions, life ventures into the inhospitable frozen zones of the polar regions, and by adaptation to such clime invades the most forbidding sphere. Earth's 'warm embrace' is here a 'cold reception,' but hosts of birds, mammals, fishes and insects have become established

and would doubtless suffer extinction in other apparently more congenial regions. Such is evidenced by the fact that certain formerly arctic forms have secured survival or at least a postponement of extinction in low latitudes by ascending mountain peaks or ranges, the assumption being that such forms were pushed southward during glacial periods and that some instead of retreating with the glacier took advantage of high latitudes to secure similar conditions. But while adaptations to the rigorous conditions of high latitudes must mean great hardihood, it also means small chance for progress in other lines and we do not look for progressive development in such situations. The Esquimaux and Laps will hardly produce Gladstones, Blaines, Leo XIII.'s, Bismarcks or Grants. But while extreme cold is unfavorable to life, extreme heat is equally so, and the limits in this direction are perhaps even more strictly marked.

Nevertheless, we find aquatic animals that have adapted themselves to life in hot springs, numerous forms living in water of 100° F., while some forms occurring in hot springs of the famous Yellowstone region exist in temperatures which, except to those especially adapted, would be destructive. On the barren slopes and crests of mountains the conditions for supporting life are also very severe, especially where altitudes are such as to leave all forest growth below or to reach into the regions of perpetual snow and ice. Still such inhospitable quarters are sought out by many animals and various small mammals, many birds and insects may be found keeping up the struggle against the boundaries to life's outskirts.

Another most interesting phase of adaptation is to be noted in the community life exhibited by ants, bees, termites and some other groups. The community habit has resulted in the development of various castes, some of which have assumed the full duty of reproduction, others fitted only for the labors or defense of the colony. In some cases slavery follows this division of labor, the members of other colonies or other species being kept in captivity and utilized in carrying on the duties of the colony except of course that of reproduction. In some species we are assured this has gone so far and the slave-making species has become so dependent on the slaves that without them they will die of starvation. Community life then is an extreme specialization offering many advantages, but at the same time entailing certain limitations, cutting off the individual from any possibility of independent existence and the colony from survival, except under the conditions that have been established with the community life. Return to primitive isolated life is manifestly impossible.

These constitute some of the most striking by-paths into which life forms have been diverted either from choice or necessity, but barely a

hint of the multitudinous minor lines of adaptation, the following of which results in limitation.

Such forms of insects, crustaceans, worms, etc., as have taken to living under bark and wood and become so flattened as conveniently to slip between the wood and bark in crevices scarcely permitting the passage of a sheet of paper—mollusks which bore into piles or some into solid rock—barnacles that fasten to ships and thus reach all climes—insects that thrive in such unnatural food material as tobacco, insect powder; or larvæ that live in brine vats, wine vats, or, perhaps most extreme, in crude petroleum. Vinegar eels in vinegar and hosts of forms that subsist upon hams, bacon, flour, meal and other prepared foods, boots, shoes and other leather goods, and furs show the readiness with which new habits are acquired. But these habits are not so easily broken, and it is doubtful if the cheese maggot, having taken up its particular dietary furnished by man, could return to the food of its ancestors before cheeses were made.

I have spoken in places of the choice of animals for a particular sphere as if this were a conscious element, and I do not care to dispute those who maintain some such element as operative in the mutations of animal life. But, conscious or unconscious, it appears to me that the animal, even in a lowly sphere, has the power to choose in some degree or other the direction of its activity, to put itself in certain environments, and while not selecting certain changes of structure by the mere fact of selecting such environment, submits itself to inevitable changes which that environment must perforce produce. Thus, an animal may not elect to become flattened in body, but selecting narrow quarters in which flattening is necessary or advantageous this change is sure to follow.

The ancestors of snakes may not have determined upon eliminating legs from their anatomy, but by choice of habitat where legs were in the way these organs were gradually reduced and lost. But by no process of electing locations where legs are helpful can we expect the animal to restore the organ thus sacrificed. The fly that mimics a bee may never in its ancestral line have started out to make itself resemble a bee, but it may have chosen such relation to bee life that a similarity became distinctly advantageous or even necessary, and then natural selection could clearly come into operation to produce the mimicry. The ancestral whale had no glimmer of thought of launching into marine life, to trade his feet for paddles and flukes, when he first by virtue of some advantage found entrance to water desirable, but once the way was entered, selection and environment conspired to carry his descendants further and further along a path which knows no backward steps.

What fearful consequences attend these unconscious selections! Shall it be persistence or progress, mere survival or advancement—the

starting on a downward path to extinction or an upward path to domination, a wanton sacrifice of rich legacies of structure or improvement of such as may be possessed?

While adaptations and progressive modifications have been the rule, there are a few striking exceptions, and we can not assert that preservation of a particular plane of development is impossible. Picture the little lamp shell, *Lingula,* living on unaltered from age to age, its fossils being found away back in the earliest Paleozoic time and in subsequent ages up to the present day—so much for staying at home and attending strictly to its own business. True no change—no progress—but as an example of the staying qualities nothing can be more striking.

Concluding, then, we may look in wide view at life as originating in most favorable conditions of moisture and temperature; as pushing out to occupy all favorable environments, and then, from the congestion of life in such places, as pushing out to extremes in various directions and, ultimately, by a process inherent in life itself, constantly but unconsciously striving to occupy every available niche having the remotest possible opportunities for the support of organic beings. The animal choosing its environment and the environment reacting to modify the structure of the animal.

But this pushing has been along different lines and some of these involve no such radical change of form or habit as to restrict the animal to a special environment. In such broad highways progressive evolution is still possible, and we may expect future modification, advancement, adaptation, the height to which advancement is possible depending on how fully the animal may preserve its general varied structure while reaching such perfection of organs as to enable it to dominate the forms with which it must compete for mastery.

Where the road narrows and the animal in traversing it is obliged to sacrifice some portion of its structure and to adopt some restriction of habit the result is a limitation which must ultimately mean a bar to all progressive evolution in the acceptance of a particular limited sphere within which it may survive, but to leave which means extinction. Adaptation to sedentary life, parasitism, desert, cave, deep sea, polar frigidity or extreme heat is to shut the door of progress and give over to mere survival.

We may be tempted to moralize a little, for a moment's thought assures us that man himself is, like other animals, subject to these inevitable laws, and that retrogression, degeneration, decay and extermination are as possible to him or to certain of his races as to any other form of life, but this subject widens into the great new field of sociology—one of the latest, richest and most important of the branches of biology.

THE CORRELATION BETWEEN MENTAL AND MORAL QUALITIES.

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IN the present article I propose to present for the first time, so far as I know, some figures proving a perfect correlation between mental and moral qualities. In addition, I have some data showing, not the birth rate, but what is more to the point, the number of children who have reached *adult* age, born to ten different groups of parents, arranged according to their moral qualities. Both series of facts taken together give us an insight into the progress of the purely intellectual faculties. They show how the *mental* level in each generation may be raised by no other force than natural selection.

The complete acceptance of the theory of the 'survival of the fittest' as an explanation of evolution has had for one of its greatest bugbears the disbelief that such a force could of itself be sufficient to explain improvement in the higher human traits. In the lower forms of animal life the advantages of intelligence in the struggle for existence are evident. Cunning and strength mean better sustenance or surer escape from natural enemies. But how can such brute forces as these be of determining significance among individuals of the human species, especially during the latter ages in which man has risen above barbarism? That man has evolved is admitted, that he will continue on the upward road is generally believed, but how is an unsolved problem.

For those who believe in the inheritance of acquired characteristics, the accumulated effects of education and superior outward advantages are the forces on which the present has been built and on which the future is to rely. For those who doubt or deny the old Lamarckian principles, and we believe an increasing number of naturalists belong to this school, no such easy explanation is at hand. Some writers consider that acquired characteristics are probably not directly inherited through the physiology of the hereditary mechanism, but that the accumulated culture of each generation creates a new environment which in each generation becomes the bequest handed on to the next. In this way institutions, scientific improvement and traditions go on from century to century in their work of building up the race. It is difficult to see how men really and essentially improved or superior in natural endowments could ever be produced through the working of such a process, even in an aeon of time. And, indeed, it is denied that

human nature has at heart changed or ever will change. To the minds of some, civilization is but a gloss and a veneer, politeness and kindliness are maintained while everything runs smoothly, but let danger or necessity arise, and they say man is again thrown back on his brute passions.

For a discussion of the question, 'Is the mean standard of faculty rising?' and the citations from various authors who consider that it is not (Buckle, Bellamy, Ritchie, Gladstone, Benjamin Kidd, *et al.*), see Lloyd Morgan, 'Habit and Instinct,' where he himself states in his closing paragraph: "Natural selection becomes more and more subordinate in the social evolution of civilized mankind; and it would seem probable with this waning of the influence of natural selection there has been a diminution also of human faculty." Alfred Russel Wallace writes:* "In one of my latest conversations with Darwin he expressed himself very gloomily on the future of humanity, on the ground that in our modern civilization natural selection had no play, and the fittest did not survive." Wallace himself insists that there are forces to be counted on for the amelioration of the race, one of which is the process of *elimination* 'by which vice, violence and recklessness so often bring about the early destruction of those addicted to them.' But it is much more difficult at first sight to see how purely intellectual qualities are to be enhanced through any process of natural selection going on at the present day. Nevertheless, if a mental and a moral correlation can be shown to be a reality the difficulty is overcome.

The following figures, which prove that the morally superior are also the more endowed mentally, were drawn from records of the characteristics of European royalty. They include the entire number who formed the basis of a study of heredity which appeared in THE POPULAR SCIENCE MONTHLY, August, 1902, to April, 1903. These were arranged to the best of the writer's ability, and in consultation with John Fiske and other historians, in ten grades for intellect and ten grades for morality. The latter term is used in its widest meaning and under this head are included all the qualities which may count as virtues. Amiability and kindliness are included, so that only those who have received praise for many good qualities can appear in the higher grades. The highest grade (10) is for those only who have been known as altruists, or reformers, or have devoted their lives to charity or other noble aims for the welfare of their country.

It has been the aim of the writer to take only the opinions of others, following the biographical dictionaries and standard histories as far as possible. If a personal equation may have unconsciously influenced the grading, it can have no possible effect on the results of the present article, because the grading was made with a view to the study of in-

* 'Studies Scientific and Social,' London, 1900, Vol. 1, p. 509.

heritance, without the least idea of carrying forward the present research. It had always been a matter of grave doubt in my own mind whether the exceptionally gifted of earth were better or worse than the ordinary run of mankind. Examples like Napoleon, Bacon, Byron and Catherine II. of Russia come to mind, and then we all have a feeling that the very good are perhaps a little simple-minded, and besides, according to tradition, they 'die young.' This pessimistic view of things is, however, not borne out by the facts.

On looking over the number of individuals in each grade one sees that nearly a half of all concerned fall in the two middle grades (5) and (6). This exemplifies what is known as 'the law of deviation from an average,' and means that when a large number of measurements are taken of any biological characteristic and graded in a numerical series, they will fall so that proportionally more lie in the grades approaching the mean and less and less as the measurements show extreme variation. On this view, then, in any homogeneous group of persons, fools are as rare as geniuses, and may differ much from the mean; but the great mass of humanity are such that in any given characteristic, one is much like another. The social scale is not to be conceived of as a pyramid in which the favored few are represented at the apex, and the masses below, more and more numerous as we descend the scale; but rather as a figure like a Rugby football with the masses occupying the medium zone. Actual paupers are as rare as the very rich. In the tables below we see the frequency in each of the ten grades for moral qualities, the males and females having been studied separately.

FEMALES.

Grades.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
Frequency.	7	8	18	24	60	42	28	23	16	6	= 232

MALES.

Grades.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
Frequency.	9	19	36	49	73	51	47	44	25	12	= 365

Space will not permit printing an entire list of 597 names or giving bibliographical references. Such details will be included in a work on the general subject of heredity in royalty which I hope will appear shortly. The three upper and three lower grades are, however, given below, and since the results of study of the extreme ends determine largely the conclusion obtained, the majority who lie close to mediocrity may just as well be given less attention.

It is, of course, difficult, indeed impossible, for any one to arrange people according to their reputed virtues in a perfectly satisfactory manner. It is, however, not as difficult as it might at first sight seem, especially if one remembers that by far the majority are to be in the

mediocre grades and the presence of some little vice or a reasonable array of good qualities are not to place a man in an extreme grade in either direction. In the case of the women the standard proved to be such that it was necessary, in order to make things balance, to place all excellent, quiet and negative characters in a grade as low as (5) and reserve the upper grades for those only who have had a special reputation for devoting their time to some form of altruism. Those who are familiar with history and court memoires may see how far the grading suits their particular approval, and most who read the list carefully will doubtless object to characters here and there; but I am sure that much of this will be found due to some personal bias, and an acquaintance with all the characters would result in a scheme not very different from the present. It is to be remembered that they are not arranged by the writer from a vague idea of their worth drawn from reading accounts of their lives, but are graded purely on a basis of the adjectives used in describing their traits by the best authorities, several different sources of information having been used for verification. In any case errors would be likely to balance.

The three lowest grades have been reserved for the distinctly vicious, those described as debauched, depraved, licentious, dissipated, cruel or extremely unprincipled. In the three upper grades we find such descriptions as 'Adored by the people as a saint,'* 'Gave herself up entirely to works of piety and charity,'† 'Heroic virtues and rare abnegations,'‡ 'By his well-known devotion to the best interests of the country he secured the confidence and esteem of all classes,'§ 'Respect and veneration which the Russians entertained for his character.'‖

In the list following, the persons within each grade are given in the alphabetical order of the country or family name, which is followed by the christian name. When the family name is omitted, it is the same as the preceding. The numbers in brackets which stand before the names are the intellectual grades in each case, and those following, without brackets, refer to the total number of children who reached adult years.

Thus (10) Anhalt, Catherine II., Empress of Russia, 1; means that she was by birth of the House of Anhalt, that she stands in grade (1) for virtues, grade (10) for mental qualities and that she left one adult child. The averages at the bottom are indicated in the same way. Illegitimate children are also included in the number.

In regard to the variability of the two sexes one sees that the con-

* Christine, dau. of Victor Emanuel I. of Savoy, and first wife of Ferdinand of Sicily.

† Anne, de Mancini, wife of Amand, Prince of Conty.

‡ Pedro II. of Portugal and Brazil, 1825–1891.

§ Leopold I. of Belgium.

‖ Feodor I. Romanhof.

clusion to be drawn is that the males are the more variable. The females fall less often in the extreme grades, which agrees with the generally accepted view. Karl Pearson has, however, doubted the greater variability of the male.*

FEMALES.

Grade (1).

(10) Anhalt, Catherine II., Empress of Russia, 1; (8) Orleans, Elizabeth, dau. Philip (Regent), 0; (5) Marie, dau. Philip (Regent), 0; (3) Russia, Elizabeth, dau. Peter the Great, 0; (1) Saxony, Anne, second wife Wm. the Silent, 2; (6) Spain, Marie Louisa, wife Charles IV., 6; (4) Queen Urraca, 1; ..... (5.28) Average 1.43.

Grade (2).

(5) Brunswick, Caroline, wife George IV. of Eng., 0; (5) Portugal, Isabella, dau. Don John, married John II. Castile, 1; (5) Mary, dau. Alfonso IV., 1; (3) Russia, Anne, 1694–1740, 0; (5) Savoy, Joanna, dau. Charles Amadeus, 1; (6) Spain, Carlotta, d. 1830, dau. Charles IV., 6; (5) Isabella II., b. 1830, 6; (6) Maria Christina, married Ferdinand VII., 2; ..... (5.00) Average 2.13.

Grade (3).

(7) Austria, Caroline, Queen of Naples, d. 1814, 7; (5) Maria Louisa, married Napoleon; (5) Bourbon, Elizabeth, dau. Louis XV., 3; (6) Brunswick, Caroline, married George IV. of England, 1; (7) Elizabeth Christine, married Frederick William II. of Prussia, 1; (8) Juliana, Queen of Denmark, 1; (4) Condé, Henrietta, dau. Louis III., 0; (5) Louise, dau. Louis III., 2; (4) Marie, dau. Louis III., 0; (5) Conty, Louise, dau. Amand, 2; (5) Medici, Marie, wife Henry IV. of France, 2; (5) Orleans, Charlotte, dau. Philip (Regent), 5; (5) Portugal, Anne, dau. John VI.; (3) Russia, Catherine, wife Peter the Great, 2; (8) Spain, Joan Henriquez, wife John II. of Aragon, 1; (6) Louise Carlotta, b. 1804, dau. Francis of the Two Cicilies, 7; (8) Theresa, dau. Alfonso I. Castile, 3; (5) Sweden, Cecilia, dau. Gustavus Wasa, 3, ... (5.66) Average 2.50.

Grade (8).

(5) Bourbon, Louise de Blois, dau. Louis XIV., 7; (5) Louise, dau. Duke de Penthièvere, 4; (10) Margaret of Navarre, grandmother of Henry IV. of France, 1; (5) Brandenburg, Anne, Queen of Denmark, 2; (9) Brunswick, Anne, dau. Saxe-Weimar (patron of Goethe, etc.), 2; (6) Elizabeth, married Charles VI. of Austria, 2; (7) Coligny, Louise, wife William the Silent, 1; (7) Condé, Louise Adelaide, 0; (4) Denmark, Caroline, dau. Frederick VI.; (4) Hanover, Caroline Elizabeth, dau. George II., 0; (6) Montmorency, Charlotte, married Condé, 3; (5) Plantagenet, Philippa, Queen of Portugal, 6; (5) Portugal, Elenor, Queen of John II., 1; (4) Marie Isabelle, dau. of John VI., 0; (6) Matilda, dau. Sancho I., 0; (9) Prussia, Amelia, sister of Frederick the Great, 0; (7) Russia, Anne, dau. Peter the Great, 0; (6) Savoy, Maria, Queen of Philip V. of Spain, 2; (8) Saxe-Meiningen, Louise Dorothea, 'the German Minerva,' 3; (8) Spain, Isabella, dau. Philip II., 0; (8) Marie, wife of Sancho IV., 6; (5) Spain, Marie Amelia, wife Louis Philippe, King of the French, 8; (7) Sancha, Queen of Ferdinand I., 5; ..... (6.35) Average 2.41.

* Conf. 'Variation in Man and Woman,' by Havelock Ellis, POPULAR SCIENCE MONTHLY, January, 1903, Vol. LXII., No. 3.

Grade (9).

(5) Austria, Elizabeth, dau. Maximilian II., 0; (5) Margaret, dau. Maximilian II., 0; (9) Maria Theresa (the great queen), 10; (9) Bourbon, Jeanne d'Albret, dau. Henry of Navarre, 2; (8) Brandenburg, Caroline, Queen of George II. of England, 7; (6) Brunswick, Charlotte, Czarina of Russia, 2; (4) Elizabeth, wife Frederick the Great, 0; (6) Denmark, Charlotte Amelia, dau. Frederick IV., 0; (9) Hanau, Amalie Landgräfin von Hessen, 4; (8) Hanover, Sophia Charlotte, Queen of Frederick I. of Prussia, 1; (5) Hesse, Charlotte Amelia, Queen of Christian V. of Denmark, 3; (5) Mecklenburg, Charlotte, Queen of George III. of England, 13; (8) Prussia, Charlotte, sister Frederick the Great and Duchess of Brunswick, 8; (8) Russia, Natalia, dau. of Alexy, 0; (8) Spain, Berengaria (famous queen), 5; (7) Stolberg, Juliana, mother William the Silent, 11; ..... (6.88) Average 4.13.

Grade (10).

(6) Hanover, Queen Victoria, 8; (5) Mancini, Anne, wife of Amand Prince of Conty, 2; (10) Prussia, Louisa Ulrica, Queen of Sweden and sister Frederick the Great, 4; (5) Savoy, Christine, dau. Victor Emanuel I., 1; (10) Spain, Isabella of Castile, 4; (8) Saint Elizabeth, Queen of Diniz I. of Portugal, 2; ..... (7.33) Average 3.50.

MALES.

Grade (1).

(1) Brunswick, Ivan, s. Anton Ulric, 0; (3) Condé, Charles de Charlois, s. Louis III., 0; (2) Denmark, Christian VII., 2; (5) Farnese, Ranuccio, 1569–1622, 6; (1) Portugal, Alfonso VI., 0; (2) Spain, Don Carlos, s. Philip II., 0; (6) Peter the Cruel, 6; (1) Philip, s. Charles III., 0; (2) Russia, Alexy, s. Peter the Great, 1; ..... (2.56) Average 1.88.

Grade (2).

(2) Bourbon, Gaston d'Orleans, s. of Henry IV., 3; (3) Louis XV., King of France, 6; (2) Hanover, Frederick Henry, b. of George III., 0; (4) George IV., King of Great Britian, 1; (4) Maillé, Urbain, 1597–1650, 2; (8) Medici, Cosimo the Great, 5; (4) Francesco, 1541–1587, 4; (2) Portugal, Cardinal Henrique, s. Emanuel I., 0; (4) Don Miguel, s. John VI., 7; (8) Russia, Constantine, s. Paul I., 0; (3) Paul I., s. Catherine II., 9; (2) Spain, Don Balthazar, s. Philip IV., 0; (1) Charles II., 0; (2) Ferdinand, Duke of Parma, 1751–1802, 4; (5) Ferdinand II. of the Two Sicilies, 7; (3) Francis I. of the Two Sicilies, 12; (3) Henry IV. of Castile, 0; (5) Philip II., 4; (5) Philip IV., 4; ..... (3.68) Average 3.58.

Grade (3).

(7) Austria, Francis IV., Duke of Modena, 4; (6) Francis V., Duke of Modena, 0; (5) Rudolph II., Emperor, 0; (2) Bourbon, Charles Duke of Berry, s. Louis the Dauphin, 0; (3) Louis XIII., King of France, 2; (4) Brandenburg, Charles William, d. 1712, 1; (7) Condé, Henry Jules, s. the Great Condé, 4; (7) Hanover, Ernst August, father of George I., 6; (3) Frederick Duke of York, s. George III., 0; (3) Frederick Prince of Wales, s. George II., 0; (3) George II., King of Great Britain, 7; (6) William Augustus, s. of George II., 0; (5) Mecklenburg, Charles Leopold, married Empress of Russia, 1; (4) Orleans, Louis Philippe (Egalité), 4; (8) Philip (Regent), 9; (7) Alfonso III., 6; (7) Alfonso IV. the Brave, 2; (3) Ferdinand, s. Peter the Rigorous, 2; (3) John III., 2; (7) Prussia, Frederick William I., 10; (9) Russia,

Peter the Great, 3; (2) Peter III., 1; (7) Saxony, Augustus I. the Strong, 2; (8) Spain, Charles V., Emperor of Austria, 5; (6) Ferdinand IV. of Castile, 2; (2) Ferdinand I. of the Two Sicilies, 7; (2) Ferdinand VII., King 1784–1833, 2; (2) Francis II. of the Two Sicilies, 1; (6) Henrique, 1823–1870, s. Francis de Paula, 5; (6) Henry II. (Transtamare), 1333–1379, 9; (8) James I. of Aragon (the Conqueror), 5; (3) John I. of Castile, 2; (7) John II. of Aragon, 4; (4) Louis, s. of Philip V. and Marie, 0; (7) Sancho IV. of Castile, 8; (6) Sweden, John III. 2; ..... (5.14) Average 3.44.

Grade (*8*).

(6) Anhalt, Charles William, 1652–1718, 2; (7) Austria, Maximilian II., 8; (6) Bourbon, Duke of Burgundy, grandson Louis XIV., 1; (5) Louis XVI., 1; (6) Louis Jean de Penthièvre, 2; (5) Brunswick, Anton Ulric, 1714–75, 5; (3) Charles, 1713–80, 8; (7) Ernest Ludwig, 1718–88, 0; (7) Ferdinand Albert I., 6; (7) Frederick August, 1740–1805, 0; (9) Coligny, Gaspard (the great admiral); (7) Condé, Louis Joseph, 2; (8) Denmark, Christian IV., 3; (5) Frederick VI., 2; (5) Farnese, Ranuccio II., 2; (4) Hanover, Duke of Kent, s. George III., 1; (7) Hesse, Philip the Magnanimous, 15; (5) Mecklenburg, Adolphus, 1738–94, 0; (5) Carl Ludwig, 1708–1752, 6; (8) Medici, Ferdinand I., 4; (4) Nassau, William IV., 2; (7) William II. (King), 4; (7) Frederick William, b. 1797, 2; (9) Orange, Maurice (celebrated general), 2; (7) William the Elder, father William the Silent, 12; (9) William III., King of Great Britain, 0; Orleans, Antoine Montpensier, brother Louis Philippe, 0; (6) Poland, Ladislaus, s. Casimier, 2; (7) Portugal, Edward I., 6; (8) Henry of Burgundy, d. 1114, 4; (10) John I. "the Great," 8; (8) John II., 2; (5) Joseph, s. John II., 4; (7) Louis, s. Emanuel, 1; (7) Sancho I., 8; (6) Sancho II., 0; (4) Savoy, Charles; (6) Saxe-Coburg, Frederick II., 9; (5) Saxe-Gotha, Frederick IV., 0; (7) Saxe-Meiningen, Anton Ulric, 5; (9) Saxony, Maurice (celebrated Elector), 1; (8) Spain, Ferdinand I., 5; (7) Sancho III., 1; ..... (6.57) Average 3.72.

Grade (*9*).

(9) Austria, Charles (commander against Napoleon), 6; (5) Ferdinand I., d. 1564, 13; (6) Ferdinand III., 6; (5) Leopold I., 6; (5) Brandenburg, Christian Frederick, d. 1806, 0; (7) Brunswick, Ferdinand, 1721–92 (General), 0; (8) William Adolphus, 1745–70 (author), 0; (8) Conty, Francis, b. 1664 (elected King of Poland), 3; (4) Hanover, Adolphus, s. George III., 3; (4) George III., 13; (7) Lorraine, Leopold, father Francis I. of Austria, 5; (6) Mecklenburg, Adolphus Frederick I., 12; (7) Montmorency, Henry II., 0; (8) Nassau, Frederick, b. 1774, 0; (6) Orange, John, Brother William the Silent, 16; (5) Portugal, Don Fernando, s. John I., 0; (9) Henry the Navigator, 0; (5) Prussia, Frederick William (late Emperor), 7; (9) Henry, brother Frederick the Great, 0; (7) Russia, Alexy, father of Peter the Great, 6; (7) Russia, Michael Feodorvitch, 1596–1645, 3; (5) Saxe-Coburg, Franz F. Anton, 7; (5) Saxe-Gotha, August, s. Frederick III., 0; (6) Ernest II., b. 1818, 0; (10) Sweden, Gustavus Wasa, d. 1559, 6; ..... (6.44) Average 4.48.

Grade (*10*).

(7) Coligony, Odet, 1515–1571, 0; (10) Orange, William the Silent, 13; (6) Portugal, Pedro II. of Brazil, 2; (7) Pedro V., king, born Saxe-Gotha, 6; (7) Russia, Feodor, the first Romanhof, 1550–1633, 1; Saxe-Coburg, Albert (consort of Victoria), 8; (6) Saxe-Gotha, August, d. 1772, 9; (7) Ernest the Pious, 9; (8) Ernest II. (the astronomer), 2; (5) Frederick III., d. 1772, 4;

(7) Leopold I. of Belgium, 3; (10) Sweden, Gustavus Adolphus, 2; ..... (7.3) Average 4.09.

Analyzing all the grades, we find that the higher grades for virtues possess a higher average of mental capacity and that this is almost perfect for both the male and female groups taken separately. An average of the two makes a curve that leaves practically nothing to be desired. There is every reason to believe that if the total were great enough the correlation would be perfect.

FEMALES.

Grades.	1	2	3	4	5	6	7	8	9	10
Correlation averages.	5.28	5.00	5.66	5.79	5.20	5.64	5.96	6.35	6.88	7.33

MALES.

Grades.	1	2	3	4	5	6	7	8	9	10
Correlation averages.	2.56	3.68	5.14	5.24	5.30	5.73	5.79	6.57	6.44	7.33

BOTH SEXES. (AVERAGED.)

Grades.	1	2	3	4	5	6	7	8	9	10
Correlation averages.	3.92	4.34	5.40	5.51	5.25	5.69	5.88	6.46	6.66	7.33

The average number of children who reached adult (21) years born to each grade is seen below to give figures representing a less smooth curve. This is probably due to an insufficiency in the total number, though I feel that this can not be dogmatically asserted.

FEMALES.

Grades.	1	2	3	4	5	6	7	8	9	10
Av. No. of adult children.	1.43	2.13	2.50	2.44	3.07	3.64	3.08	2.41	4.13	3.50

MALES.

Grades.	1	2	3	4	5	6	7	8	9	10
Av. No. of adult children.	1.88	3.58	3.44	2.41	3.58	3.46	3.04	3.72	4.48	4.09

BOTH SEXES. (AVERAGED.)

Grades.	1	2	3	4	5	6	7	8	9	10
Av. No. of adult children.	1.66	2.86	2.97	2.43	3.33	3.55	3.06	3.07	4.31	3.80

Such figures drawn from royalty, in regard to the fertility of different grades, can have, of course, but a slight bearing on the question of race suicide agitated at the present time. They do, however, show that, unhampered by restraint, as is fair to suppose has been the case

among royalty where large families are always desired, maximum fertility does on the whole run hand in hand with general superiority. Nearly all the figures which have been heretofore compiled upon the question deal only with the number born and not with the number reaching adult years and are consequently of absolutely no significance. It is a well-known biological principle that the lower the species the greater the number of offspring, but among the different members of any social scale, our foreign immigrants for instance, very likely it would be found on close inquiry that, *inter se*, the relatively superior are the ones who are parents of the greater number of children whom they are successful in bringing to mature years. There are many reasons, both medical and economic, why the children of the more vicious and depraved should die in the greater numbers. This, in the long run, must raise the moral average, and as mental qualities are correlated with the moral, the intellectual level must at the same time be raised.

Besides these problems touching upon natural selection there is another question upon which I wish to say a few words. I refer to the opinion so generally entertained regarding the psychological effect of the inheritance of great financial wealth. Wallace in his 'Studies Scientific and Social,' Vol. II., p. 519, in a paragraph headed 'Hereditary Wealth Bad for its Recipients,' writes:

> There is yet another consideration which leads to the same conclusion as to the evil of hereditary or unearned wealth—its injurious effects to those who receive it, and through them to the whole community. It is only the strongest and most evenly balanced natures that can pass unscathed through the ordeal of knowing that enormous wealth is to be theirs on the death of a parent or relative. The worst vices of our rotten civilization are fostered by this class of prodigals, surrounded by a crowd of gamblers and other parasites who assist in their debaucheries and seek every opportunity of obtaining a share of the plunder. This class of evils is too well known and comes too frequently and too prominently before the public to need dwelling upon here; but it serves to complete the proof of the evil effects of private inheritance, and to demonstrate in a practical way the need for the adoption of the just principle of equality of opportunity.

That instances of this sort do come too frequently before the public I do not deny. The vices of the aristocracy are always made the most of by the polychrome daily press, but if Mr. Wallace or any one else has any data to show that vices among the rich are proportionally more frequent than among people in general, I have never seen such a proof. It is an assertion entirely unwarranted by any facts. It is merely a popular fallacy which will probably be entirely abandoned as soon as sociology has properly collected data bearing on modern life. In the first place, it is unlikely on *à priori* grounds. Wealth, like most things in life, is essentially relative. To the young man who is to inherit a few thousand dollars, if he belongs in the middle classes, the

amount seems as much as the same number of millions to one whose friends all have as much. There are plenty of temptations within the reach of all classes of society and many demoralizing amusements come cheap. Besides, if this view of the evil effects of great wealth were true, royalty, who are among the richest of the world's favored few, should make a poor showing from the general standpoint of morality. Although we may think at first sight that this is the case, I have been able to show in some former articles in this magazine that the bad characters practically always come as close relations of others of the same stamp, and due to heredity with perhaps some influence from environment. They can not at any rate be explained on the ground of riches, as here all are rich. Furthermore, royalty does not make a bad showing when taken as a great group. From the intellectual side they are distinctly above the average and this six hundred contains more great names than probably any other collection of related people that could be gathered together, certainly more than the general run of Europeans. Even the greatest leaders among them were born in all cases to extremely high positions. An idea of their moral standard may best be gained by looking at their mean or (5) and (6) grades. Among the more modern and best known in these grades are the late Humbert, King of Italy, William I., Emperor of Germany, Frederick William IV. of Prussia, Louis Philippe and Francis Prince de Joinville, his son; doubtless men with faults, but at the same time men with certain decidedly praiseworthy traits and in most instances men who led active lives.

Wallace relies much on sexual selection to play an important part in the future, as a causative force in human evolution, and has written some good arguments to this effect. Royal matches, as is well known, are largely determined by reasons of state policy. Nevertheless, even here, in a class of society where any force of sexual selection must be relatively at its lowest, we see the largest number of children on the average belonging to the higher grades. There is also a pretty definite elimination of the worst.

Conclusions.—There is a very distinct correlation in royalty between mental and moral qualities. If this is true among them, there is no reason why it should not be true in every class of mankind. Among society in general it is easy to see how the vicious and depraved are more likely to be eliminated than the domestic and unselfish. Arguments, then, which prove that an improvement is going on in the general morality of any class or race must at the same time prove an increase in the standard of mental faculty. The probability is that forces of natural selection are at work, the value of which we know little of as yet, such that setting aside all influences of environment, whether we will or not, the natural quality of humanity must progress.

COOPERATION, COERCION, COMPETITION.

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UNDER the title, 'Cooperation, Coercion, Competition,' I propose to consider the three characteristic systems of industrial organization. Having set forth in a few words what appear to me to be the determining factors of industrial organization, in the first part of my paper I shall endeavor to show that the three systems of association have succeeded each other historically in the order named, that in primitive times, before the appropriation of natural resources, the cooperative system prevailed, that during the proprietary period which followed, when natural resources were appropriated but before the institution of exchange, the cooperative system became subservient to the coercive system, and that with the rise of the commercial era resulting from the development of exchange, the coercive system was superseded by the competitive system. In the second part of my paper I intend to draw attention to certain tendencies which appear to me to point toward a reversal of the original order of evolution. Having shown why the competitive system was necessarily a transitional form, I shall indicate how it is now being superseded by the coercive system, and in conclusion I shall endeavor to demonstrate that the ultimate outcome must be the reestablishment of the original cooperative system.

My main proposition is that industrial organization is determined by two factors: first, by the character of the social surplus, and second, by the monopolization of the sources thereof. Instead of stopping to prove this proposition I shall proceed at once with the historical survey, hoping that in the course of such survey the requisite proof will be forthcoming.

During the earliest days of human development, when people lived in what political philosophers have called the natural state, the surplus was derived from fishing, hunting, nut-gathering, berry-picking and root-culture. In this savage, or so-called natural state, the character of the surplus was such as sometimes to call simply for sexual association of labor and sometimes to require personal association of labor. To cite a few examples: for shore-fishing, river-fishing and forest-hunting, nut-gathering, berry-picking and primitive root-culture, sexual association of labor was sufficient, and we find the peoples pursuing these occupations organized accordingly along domestic lines. On the

other hand, sea-fishing and plain-hunting to be successful had to be carried on by clans or cooperating companies of virile males—manly-men, as they were called—and as root-culture advanced from the original essartage methods to the more complicated plantation system, the association of the women and womanly-men was found essential. As far as these latter cases were concerned, therefore, the character of the surplus required personal association of labor and in this way the co-operative system was originally established.

Whether the character of the surplus was such as to require sexual or personal association of labor, in the natural state, the sources of the surplus were far too widespread to admit of monopolization. True, the spawning grounds of fish might be closed in to some extent, but for the most part, fishing, hunting and primitive agricultural opportunities were too far dispersed to be monopolized by any one party within the community to the exclusion of others. As a result, access to the surplus source was not restricted to any particular class. Where the character of the surplus was such as to require only sexual association of labor, there each family had immediate access to the surplus source and the individual members were dependent upon the domestic group for their livelihood. Where the character of the surplus was such as to require personal association of labor, there the cooperating company had immediate access to the surplus source and the individual members were dependent upon the clan for their livelihood. But though in both cases individuals were dependent upon the group to which they belonged, still no one set of individuals was dependent upon another set of individuals for their livelihood. In short, the fact that the surplus source could not be controlled precluded the possibility of coercion and left the cooperative system supreme in the natural state.

During the proprietary period which succeeded the natural state the surplus was derived primarily from cattle-raising and agriculture. For the development of the pastoral surplus personal association was necessary for the defense of the flock and for the occupation and defense of pasture lands, with the result that we find the manly-men of pastoral peoples organized like the hunters of the plain into military companies under a competent chief. For the development of the agricultural surplus personal association of labor was not everywhere necessary. In the temperate zone, where the extensive system of agriculture was most profitable, the land could best be cleared and cultivated by individual families. In the subtropical zone, however, agricultural opportunities were confined to certain favored localities, such as oases, river valleys or lakesides, where irrigation and hoe and spade culture were necessary. These conditions called for intensive agriculture and this in turn necessitated the associated labor of men, women and even children. In summarizing, therefore, we may say that during the proprietary period the

character of the surplus was such as to call for cooperation among pastoral peoples and intensive agriculturists, while among extensive agriculturists the familial or domestic system was found sufficient.

The sources of the pastoral surplus might be monopolized to a considerable extent, since herds of domesticated animals were not goods freely reproducible by labor alone. A single individual or a company of cooperating individuals might by labor alone bring down the wild beasts of the forest and plain, but they could not secure a herd of domesticated animals in this way. Herds and flocks were products of generation and their possession was accordingly confined to the comparatively few who had inherited such stocks from their ancestors. These proprietors were, therefore, in their way monopolists who controlled the pastoral surplus source. As for the rest, they could only gain access to this surplus source by serving the proprietors and receiving in return from them either the products of the existing herd or the nucleus of a new. To the extent, then, that the non-proprietors were dependent upon the herd for their livelihood, they could be coerced by the proprietors. It should be borne in mind, however, that the proprietors were also dependent to some extent upon the non-proprietors for the defense of their herds and pasture lands. For this reason they were forced to mitigate the rigor of coercion in order to secure the advantages of cooperation.

The sources of the agricultural surplus were either widespread or confined. In the subtropical zone where the sources of the agricultural surplus were confined it was a comparatively simple matter for a group of conquerors or usurpers to secure control. In the temperate zone, however, where the sources of the agricultural surplus were spread out over a wide area, monopolization was more difficult. By conquest and through inheritance such control was, however, eventually obtained, except where the surplus was not rich enough to make such monopolization worth while. In both cases when proprietorship was established the disinherited peasants were henceforth dependent upon their landlords for their livelihood, for they no longer had free access to the surplus source. As a result, in agricultural regions the coercive system was established in all its rigor during what we speak of as the feudal ages.

The commercial era may be said to have begun with the differentiation of occupations, the institution of markets and the introduction of coined money. With the resultant development of exchange a new surplus source was opened up whose utility producing capacity was practically boundless, provided appropriate means and methods for its exploitation could be devised. In this enquiry we are concerned with the methods rather than with the means of production, with the system

of organization rather than with the kinds of capital required for the development of the industrial surplus source.

For trade and commerce the familial system was found inadequate from the outset. For handicraft and manufacture also the domestic system was only applicable in certain circumstances and to a limited extent at that. On the whole, therefore, the development of industry and commerce is characterized by the extensive and intensive application of the personal system of association. During the early days of the craft and merchant guilds the cooperative system included all classes of producers, the apprentices, the journeymen and the guild masters. Later on when the wage system was established there was a differentiation of cooperative groups, the apprentices and journeymen cooperating henceforth as industrial laborers, and the masters combining as capitalists in partnerships, companies and corporations. This differentiation of cooperative groups was due to the gradual monopolization of the sources of the industrial surplus. We should accordingly shift our standpoint slightly and study the subject from this side.

At first the sources of the industrial surplus were too widespread to admit of monopolization. As a result, the early guilds were organized along purely cooperative lines. As each guild chose its particular line of production, the then existing surplus sources came in time by custom to be regarded as monopolies of the several guilds. But as every member of the community was allowed to join a guild and rise from apprentice to journeyman, to master, such collective monopolies worked no injury to any one. It had the effect, however, of restricting the normal development of industry. Beyond the limited lines of production controlled by the guilds there were practically limitless industrial opportunities open to those who would work for themselves. This being the case, the guilds—even though they sought and for the most part obtained the support of the state—were not able to hold their artificial monopolies of the surplus sources. Not to go into the history of the subject, suffice it to say that in some countries by revolution and in others through peaceful progress, the older guild privileges were everywhere broken down and industrial opportunities opened to all. In this manner the way was cleared for the development of the competitive system, which was a compromise of the older cooperative and coercive systems, and a transitional stage, as it were, between the two.

Under the new régime the surplus sources were opened to competition, and by the laws of private property each producer was allowed to hold and pass by testament so much of the surplus source as he succeeded in developing. In considering the conditions of this contest it should be noted at the outset that for the development of the industrial surplus organized labor was not enough; a certain amount—

and with the progress of industry an increasing amount—of capital was required. So from the first those that possessed capital had a superior claim to the control of the surplus source, and as industry developed the validity of this claim increased. Those that had labor alone to offer were consequently compelled to work for wages for those who had capital to contribute; but if from their wages the laborers could save enough, they too might become capitalists and enter upon the competitive struggle on their own account. Nor among the capitalists were the conditions of the contest entirely equal. For the development of some surplus sources more capital was required than for the development of others; and again, though as far as the surplus source itself was concerned, small capital could compete with large capital, still by reason of the economy of great organizations the small capitalist might nevertheless be at a disadvantage. So from the first the large capitalist had a superior claim to the control of the surplus source, and with the development of industry the validity of this claim also increased.

From this it is evident that the competitive system must result in the gradual elimination of the weaker competitors until in the end only the strong survive. Indeed, this movement has already gone so far as to be unmistakable, particularly in this land of ours where the competitive system was given the fairest chance to prove its economic efficiency. As the competitive field was gradually restricted, the laborers naturally were first excluded. Though they continued to save, as time went on they found that more and more capital was required to enter into business for themselves, either because the industries in their neighborhood were already absorbed by large capitalists, or because the industries they might still embark upon with their small capital were far removed from their neighborhood. The next to be excluded from the competitive struggle were the small capitalists. As some capitalists secured control of the natural monopolies and others succeeded in establishing artificial monopolies, the small producers were unable to hold their own on the market and one by one they have either been extinguished by or absorbed in the larger concerns, until now, as a matter of fact, only the few strong competitors remain.

Properly interpreted this modern movement so familiar to us all means simply this: the gradual monopolization of the sources of the industrial surplus. Formerly these surplus sources were too widespread to be monopolized, hence the passing existence of the competitive system; but nowadays the ramifications of capital are nearly as widespread as the surplus sources themselves, hence, as I see it, the inevitable recrudescence of the coercive system. By the opening up of new lands through colonization and by the development of fresh surplus sources through invention, this movement has been stayed time

and time again in the past; but as colonies and inventions are immediately monopolized nowadays we need not expect much further obstruction from these factors. It is high time, therefore, that we faced the problem. Instead of trying to stimulate the competitive system, which is really moribund, we should accept the situation as it is and ask what the new coercive system signifies, how long it will last and what system will probably succeed it.

It is a fact beyond dispute, I believe—though I confess with the short space at my disposal I have not been able to present more than passing proof of the fact—that to the extent that the sources of the surplus are monopolized, to just such extent can the monopolizers coerce those shut out of such monopoly. During the middle ages the coercive system was established, as we have seen, through the monopolization of the sources of the agricultural surplus by powerful feudal lords. Being dependent upon the feudal lords for their land, the peasants were deprived of free access to the agricultural surplus source, and could consequently be coerced. In our day the coercive system is being reestablished through the monopolization of the sources of the industrial surplus by the great capitalists. Becoming dependent upon these capitalists for their jobs, wage-earners and salaried men generally are being deprived of free access to the industrial surplus sources and to this extent they too are being coerced. As throughout the middle ages a few free peasant communities remained, so in modern times independent producers persist in some industries. Still as most of the land was feudalized in medieval times, the free peasants existed more by sufferance than by right; and as the main lines of industry are nowadays controlled by great capitalists, the existing independence of the small producer is nominal rather than real.

But freemen have never submitted to coercion with good grace if there was any way to throw off the yoke. For this reason coercion has never proved itself in the end a productive system of association; it runs faster, so to speak, toward the law of diminishing returns than any other system thus far devised. These facts are fundamental and serve to suggest the probable outcome of the existing situation. Let us therefore regard present conditions from this point of view.

As soon as the wage-earners recognized that despite their saving they could not become capitalists, they began at once to present an organized front to coercion. Up to this time the forces of labor had been associated for the purpose of increasing the profits of capital. Henceforth the laborers themselves began to organize their own forces with a view to raising the wages of labor. Trade unionism was the result. It was then that the shield was reversed and the other side exposed to view. It had become evident enough in the past that labor could not develop the industrial surplus source without capital; recently it has

become equally evident that capital can not develop the industrial surplus source without labor. Indeed, one has not to examine the situation very closely to become convinced that the once disfranchised wage-earners are rapidly regaining as organized unions what they lost as individuals, viz., a claim—and a valid claim at that—to some share in the control of the industrial surplus source. To the extent that such claim can be established through association, to just such extent, therefore, can coercion be mitigated. On this account it does not appear to me at all unlikely that capitalists will tire in time of trying to enforce coercive measures, if for no other reason, because they will find coercion in the end too costly. That is to say, with diminishing returns staring them in the face because of the antagonism of trade unionism, I can readily see how capitalists may find it to their advantage to forego exclusive control of their surplus sources and admit their laborers into their monopolies by giving them shares in their companies. And if this movement—which is already well advanced—toward profit-sharing proceeds, ultimately the existing coercive relation between employer and employee will be replaced by the cooperative system, and the old guild organization will be reestablished on a very much larger scale.

But supposing the coercive system between capitalists and laborers to be succeeded in this way by the cooperative system among producers, there is still another class to be considered, namely, the consumers. The new guilds, if established, would differ from the old guilds in this, that they would actually control the headwaters of the industrial surplus, while their predecessors only controlled a few incipient streams. If they chose—and as their profits would be increased thereby they might very well so choose—they could coerce consumers by demanding monopoly prices for their products. Under the existing régime we have had a taste of this sort of coercion as applied by the capitalists alone, we can well imagine, therefore, what it would mean when applied by capitalists and laborers combined. But here again, in spite of present appearances, coercion must in the long run prove unprofitable. The consumers do not represent a particular class, as do the laborers and the capitalists, nor are their interests divided, as are those of the producers. On the contrary, the consumers represent the entire community, and public opinion is always united for fair prices and efficient service. Monopoly prices and poor service touch the public's pocket, as we say, and arouse resistance at once. When things go well enough the consumers are satisfied, but let pressure be exerted on any side by producers, it is remarkable how vigorously they resist. Agitation quickly leads to association, and when combined consumers can readily bring recalcitrant producers to terms, either by boycotting their products, or, if this is not enough, by assuming control of the surplus source themselves. This latter plan has been adopted to a considerable extent in

Europe, where many industries are already municipalized or nationalized, and in our middle western cities it looks as though the trolley companies would pay the same penalty for charging what the people consider high fares.

However we look at it, therefore, the existing system of coercion as applied by the present monopolizers of the social surplus sources appears to be confronted by opposing forces. When pushed too far coercion is met by cooperation and diminishing returns set in. Already cooperation is acting as a powerful check upon such coercion as exists, and as we advance a little further I expect to see the coercive system broken down bit by bit, first by the cooperation of capitalists and laborers in profit-sharing undertakings, and next, where necessary, by the socialization of such industries as prove recalcitrant under the new order of things. Or to put the thought theoretically, I think we may expect the present monopolization of the surplus sources to be extended gradually to admit laborers as well as capitalists, and finally, perhaps, some monopolies to be still further extended so as to admit consumers as well as producers.

THE SHERMAN PRINCIPLE IN RHETORIC AND ITS RESTRICTIONS.

By Dr. ROBERT E. MORITZ,
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FIFTEEN years ago, Professor L. A. Sherman, of the University of Nebraska, while investigating the sentence-lengths used by early and modern English writers, noticed that in the works which he examined each author manifested an average sentence-length, which he inferred to be characteristic of the author. Consecutive hundreds of periods were averaged with respect to the number of words per sentence and the mean of five or more of these averages was taken to represent approximately the average sentence-length used by the author. It was found that the averages for separate hundreds generally varied by less than 20 per cent. from the total average of 500 to 1,000 sentences. The 2,225 periods of De Quincey's 'Opium-Eater' averaged 33.65 ± 6.64 words per sentence, where the number 6.64 indicates the largest number of words by which the averages of individual hundreds differ from the average 33.65. Similarly 722 periods from Macaulay's 'Essay on History' yielded 23 ± 3.35 words per sentence, 750 periods from Channing's 'Self-Culture' 25.35 ± 1.45, 732 periods from Emerson's 'American Scholar' and the 'Divinity School Address' 20.71 ± 2.65 and 805 periods from Bartol's 'Radicalism' and 'Father Taylor' gave an average of 16.63 ± 2.35 words per sentence. These results led to the suspicion that stylists are 'subject to a rigid rhythmic law from which even by the widest range and variety of sentence length and form they may not escape.' Averages from other authors were made with similar results. A culminating test was furnished by actually counting the words in each of the 41,500 periods in the five volumes of Macaulay's 'History of England' with the resulting average of 23.43 ± 7.11. The conclusion was that writers who have achieved a style are governed by a constant sentence rhythm, which will generally be revealed by an examination of 300 periods.

Encouraged by these results, Professor Sherman induced Mr. Gerwig, then a student at the University of Nebraska, to examine other stylistic peculiarities. This Mr. Gerwig did by determining the average number of predications per sentence and the percentage of simple sentences used by one hundred different authors. His conclusions are summed up in the following words: "A very little investigation served to convince me that the same remarkable uniformity which had been

found in the average number of words used by any given author per sentence would also hold in regard to the number of finite verbs, or predications, found in each sentence. The results obtained convinced me also that there was a uniformity in the number of simple sentences per hundred of a given author.'' Mr. Gerwig expresses his conviction that the average number of predications and simple sentences in five hundred periods of any author who has achieved a style is approximately the average of his whole work. In particular he found that 'while Chaucer and Spenser put habitually over five main verbs in each sentence they wrote, and less than ten simple sentences in each hundred, Macaulay and Emerson used only a little over two verbs per sentence, and left over thirty-five verbs in each hundred simple.'

The theory which has grown out of these investigations has been most tersely stated by Mr. Hildreth, another student of Professor Sherman, who at the same time applies the theory to the Bacon-Shakespeare controversy. We read:

> Ten years or more ago Professor Sherman, while investigating the course of stylistic evolution in English prose, made the discovery that authors indicate their individuality by constant sentence proportions, personal and peculiar to themselves. This was demonstrated especially with the number of words used per sentence in large averagings. It was found that De Quincey, Channing and Macaulay, if five hundred periods or more were taken, evinced this average invariably, and in the earliest as well as in the latest period of their authorship. This discovery led to the suspicion that good writers would be found constant in predication averages, in per cent. of simple sentences, and other stylistic details. Acting upon a suggestion to this effect, Mr. G. W. Gerwig, then a pupil of Professor Sherman, undertook an investigation that established the constancy of predication, as well as simple-sentence frequency, in given authors. . . . Professor Sherman and Mr. Gerwig have thus established by an examination of a great many authors, that writers are structurally consistent with themselves; that they possess a certain sentence-sense peculiarly their own. These investigators have established that by this instinct authors use a constant average sentence-length, and a certain number of predications per sentence, and that a given per cent. of their sentences will be simple sentences. . . . The work of these investigators covers a large amount of material and a wide field of literature. They have examined and compared the works of ancient and recent authors, early and late writings of the same author, and writings of the same author of different character, such as history and dialogue, poetry and prose.* The results thus far obtained are sufficient to show that it is not possible for a writer to escape from his stylistic peculiarities.

The principle once established, its application to cases of disputed authorship is very plain. If each author employs but one set of average sentence proportions such as sentence-length, predication average and simple sentence frequency, it is only necessary to determine these constants for a disputed work and compare them with those of its supposed author. If the two sets of constants manifest a striking differ-

* This Professor Sherman tells me is an oversight. Neither he nor Mr. Gerwig think that the principle in question applies to poetry.

ence, it is conclusive evidence that the supposed author did not write the disputed work; if they are practically identical, the evidence is in favor of the supposed author, for it is highly improbable that two sets of three numbers each, taken at random, should happen to coincide.

Following this or some similar line of thought, Mr. Hildreth examined the prose in fifteen of Shakespeare's plays and of Bacon's 'Essays' and a portion of the 'New Atlantis.' To eliminate possible errors arising from careless or inconsistent punctuation, all the material was repunctuated according to modern principles. All inorganic and broken sentences were omitted. Then follow twelve pages of figures representing totals and specimen results, and then the summary.

SUMMARY.

	No. of Sentences Examined.	No. of Words per Sentence.	No. of Predications per Sentence.	Per Cent. of Simple Sentences.
Shakespeare.....	5,002	12.39	1.70	39
Bacon.....	2,041	32.59	3.45	14

The reader is left free to draw his own conclusion from these figures. The closing statement is that the numbers are not presented as proof conclusive, but only as contributory evidence in the controversy.

Without wishing to deny the general principle of sentence-rhythm, which, in honor of its discoverer, I shall refer to as the Sherman principle in rhetoric, I wish to point out certain limitations to this principle, which I think will invalidate the conclusion that must otherwise be drawn from the above summary. The Sherman principle has been established only for certain normal forms of composition, a fact which has been overlooked in the statement of the principle, as well as in its applications. What has been shown is that a writer uses definite sentence proportions while writing in a certain form of composition; it has not been shown that he uses the same proportions when he employs essentially different forms of composition, such as drama and description, criticism and correspondence. It is almost obvious that the sentence proportions of a philosophic discourse must differ from those employed in light fiction or the drama, yet this fact is not only overlooked, but directly denied in Mr. Hildreth's statement of the Sherman principle. To compare the sentence structure of dramatic compositions with the sentence structure of a heavy dissertation or description is to compare the oral utterances of a person engaged in deep contemplation or in vivid imagination of some sublime object with the commonplace talk of the drawing-room or the vernacular of the market-place. Quite as plausible would it seem to assert that a man's average gait in walking is the same whether he is out for pleasure, on business, to escape from danger, or on a long journey.

The chief fact which apparently gives weight to the persistence of sentence proportions, regardless of the composition employed, is the instance of Macaulay's 'History of England,' for which the sentence constants are practically the same as those of his essays, notwithstanding that some parts of the 'History,' in particular the second volume, contain much dialogue. This anomaly is explained by the fact that taking the five volumes as a whole the essay style predominates to such an extent as practically to obliterate the disturbing effect of the dialogue portions. This is easily demonstrated. The average sentence length of 'Macaulay's History' is 24.43, which differs but little from 23.65 of Machiavelli, 24.00 of Pitt and 23.00 of the 'Essay on History'

VARIATION OF SENTENCE-LENGTH IN TEN AUTHORS.

	No. of Sentences.	Average Number of Words per Sentence.					
		First 100.	Second 100.	Third 100.	Fourth 100.	Fifth 100.	Av. of 500.
Swift.							
'Polite Conversation'	500	10.8	12.0	12.1	13.7	13.6	**12.4**
'Essay on the four last years of Queen Anne'	500	51.6	49.3	58.2	62.1	53.0	**54.8**
Dryden.							
'The Mock-Astrologer'	500	15.0	16.5	19.6	17.1	16.3	**16.9**
'Essay on Satire'	500	45.0	48.1	40.1	44.8	33.3	**42.3**
Goldsmith.							
'She Stoops to Conquer'	500	13.9	13.1	13.2	14.9	12.4	**13.5**
'The Vicar of Wakefield'	500	31.2	30.8	27.5	25.8	26.5	**28.4**
'Present State of P. Learning in Europe'	500	30.4	24.6	25.7	23.5	20.4	**24.9**
Scott.							
'Life of Napoleon'	500	46.0	47.0	50.0	49.8	46.5	**47.9**
'Auchindrane'	500	19.1	21.9	23.9	19.2	21.8	**21.2**
'Ivanhoe'	500	46.2	35.3	33.7	29.8	32.2	**35.4**
Carlyle.							
'Signs of the Times,' etc	500	27.4	31.8	26.9	34.5	42.3	**32.6**
'The Hero as Divinity'	500	25.2	21.5	24.3	23.5	23.4	**23.6**
Bayard Taylor.							
'The Prophet'	500	15.8	11.8	11.3	14.8	16.4	**14.0**
'Balearic Days'	500	30.3	29.3	27.8	26.6	27.6	**28.3**
Lowell.							
'Letters,' Vol. II	500	18.8	18.2	22.5	21.8	17.2	**19.7**
'Fable for Critics'	180						**96.6**
Holmes.							
'Guardian Angel'	500	26.4	29.0	32.2	31.1	25.6	**28.9**
'The Autocrat at the Breakfast Table'	500	19.7	18.8	18.0	23.8	20.1	**20.1**
Longfellow.							
'The Spanish Student'	500	12.0	8.8	11.1	8.8	10.1	**10.2**
'Hyperion'	500	20.5	25.4	27.5	24.3	21.3	**23.8**
Schiller.							
'The Robbers' *	2500	12.2	11.4	12.6	10.2	10.9	**11.5**
'History of Thirty Years' War'	500	29.9	27.8	28.3	24.9	25.7	**27.3**

* The averages except the last are for 500 periods.

by the same author. Now of the 41,500 periods of the 'History,' there are forty-five hundreds whose average is less than twenty words per sentence. These we may take to represent the dialogue portions of the work. The exact average of these 4,500 periods is 18.62 words per sentence, that is, 4.81 words per sentence less than the average for the entire 'History.' If we replace these sentences by others of normal length, we augment the total aggregate by 4,500 times 4.81 or 21,645 words. That is, if the portions of the 'History' which contain an excessive amount of dialogue were replaced by an equal number of sentences of normal length, the five volumes would contain $41{,}500 \times 23.43 + 21{,}645$ or 993,990 words. Dividing this number by 41,500 we obtain 23.95 words per sentence, a result not essentially different from the actual average, 24.43.

But whether the presumption is for or against limitations of the Sherman principles is of little consequence in a matter so easily tested by experiment. I have prepared a table giving the approximate sentence-lengths for widely divergent forms of composition by the same author. The averages by hundreds, as well as the final average, have been given in order to show the variation in the averages of consecutive hundreds in each work.

It is needless to continue this table, for a mere inspection of the figures already given must once and for all settle the 'single set of constants' theory. In fact the question suggests itself, whether the number of different sets of constants which an author may employ is not limited merely by his versatility as a writer. So far as sentence-length is concerned, this conjecture is fully corroborated by a partial examination of Goethe's works. The results are exhibited in the following table:

VARIATION IN THE SENTENCE-LENGTH OF GOETHE'S WRITINGS.

Title of Work.	No. of Sentences.	Average Number of Words per Sentence.					
		First 100.	Second 100.	Third 100.	Fourth 100.	Fifth 100.	Av. of 500.
'Der Buergergeneral'.....	500	6.7	5.1	4.5	3.9	4.7	**5.0**
'Goetz v. Berlichingen'*.....	2500	8.7	9.2	8.7	7.8	8.1	**8.5**
'Letters to Frau v. Stein'....	500	13.5	12.5	11.3	11.2	12.4	**12.2**
'Faust': First Part.....	500	14.6	15.2	13.6	13.0	12.0	**13.7**
'Faust': Second Part.....	500	16.3	17.2	15.5	12.3	16.5	**15.6**
'Reinecke Fuchs'.....	500	18.5	16.5	16.9	14.8	16.6	**16.7**
'Die Leiden d. j. Werthers'...	500	20.7	20.9	19.1	22.7	18.2	**20.3**
'Italiaenische Reise: Rom'...	500	23.1	23.7	22.7	21.5	22.7	**22.7**
'Die Wahlverwandtschaften'..	500	21.9	23.6	23.7	25.1	24.5	**23.4**
'Briefe aus der Schweiz'.....	500	23.2	26.5	25.6	23.0	28.4	**25.3**
'Entwurf einer Farbenlehre'...	500	28.4	25.7	29.3	22.3	26.1	**26.4**
'Bildhauerkunst'.....	500	27.1	32.9	33.7	27.0	36.9	**31.5**
'Dichtung u. Wahrheit'.....	500	31.5	36.1	30.9	28.9	31.1	**31.7**
'Metamorphose d. Pflanzen'...	288	33.8	34.1				**33.7**
'Literatur: Recensionen'....	500	37.3	32.9	36.9	31.7	34.9	**34.7**

* The individual averages are for 500 periods each, the total for 2,500 periods.

The above list includes romance, drama, allegory, criticism, biography, description, science and correspondence, but with the exception of 'Faust' and 'Reinecke Fuchs' the works are all in prose, so that the fact of variation is not disturbed even if we consider prose literature alone. There can be little doubt that a complete examination of Goethe's writings would furnish a chain of sentence-lengths varying by almost insensible gradations from five to thirty-five or forty words per sentence.

The conclusion from which there seems to be no escape is that the average sentence-length used by an author depends upon at least two factors, one of which is the author's sentence sense, the other the particular form of composition into which his thought is cast.

What is true of sentence-length holds equally true of predication averages and simple sentence percentages. Other things being equal, the shorter sentences will naturally contain the fewer predications, and a larger per cent. of simple sentences, the limits being single predications, on the one hand, and none but simple sentences, on the other. This general relation is fully made good by the facts. Macaulay, in his 'History of England,' uses 23.3 words per sentence and 2.3 finite verbs, which is almost exactly ten words to one verb. Nearly the same ratio obtains in More's 'Life of Richard III.' with an average of 3.65 verbs out of 36.5 words per sentence; Hooker's 'Ecclesiastical Polity,' with an average of 4.12 verbs and 40.9 words per sentence; Sidney's 'Defense of Poesie,' 3.98 verbs and 39.3 words per sentence; and Channing's 'Self-Culture' employs 2.57 verbs out of a total of 25.9 words per sentence. However, in very short sentences there is a tendency to diminish and in very long sentences to increase the ratio of the total number of words to the number of verbs per sentence. Thus Emerson in his 'Divinity School Address' uses 2.14 verbs and 18.0 words per sentence, while Hakluyt in the 'Voyages of the English Nation to America' uses but 4.44 verbs out of an average of 56.8 words per sentence.

A more striking though less obvious relation exists between predication averages and simple sentence percentages, which is all the more surprising, inasmuch as simple sentence percentages are the least constant of the sentence proportions thus far examined. For instance, Lyly's 'Euphues' furnishes for five consecutive hundreds 26, 14, 20, 15 and 8 simple sentences respectively. De Quincey's 'Opium-Eater' yields the numbers 10, 19, 15, 7 and 21 for consecutive hundreds, and Macaulay in his 'History of England' gives simple sentence percentages as widely divergent as 41 and 27, though each average is based upon 500 consecutive sentences. These are extreme cases, but even the average variation is high. An examination of fifty authors shows that the simple sentence percentages based upon an examination of 400 sentences, differs

on an average by nearly 6 per cent. (5.98 per cent.) from the averages based upon 500 sentences from each author, with extreme variations as high as 28.8 per cent. It seems quite plain, therefore, that several thousand sentences from each author would have to be examined to get anything like a constant simple sentence percentage.

Now Mr. Gerwig's tables* for predication averages and simple sentence percentages for prose works comprise averages of about 60,000 sentences taken from seventy-one different authors, exclusive of the complete averages for Macaulay's 'History.' These tables I utilized for a preliminary test† by employing the following device. I grouped together all the works whose predication averages fell between 1.50 and 2.00 per sentence. This group yielded an average of 1.83 predications per sentence and 53 simple sentences per hundred. Next I averaged the works which contained between 2.00 and 2.25 predications per sentence, and the average for this group was found to be 2.15 verbs per sentence and 38 simple sentences per hundred. Proceeding similarly by grouping the works whose predication averages fall between 2.25 and 2.50, between 2.50 and 2.75, and so on, we obtain the following table:

Index.	Predications per Sentence Between.	Averages.		$P\sqrt{S}$
		P	S	
1	1.50 and 2.00	1.86	53.0	13.54
2	2.00 " 2.25	2.14	39.1	13.38
3	2.25 " 2.50	2.34	32.9	13.41
4	2.50 " 2.75	2.62	25.9	13.33
5	2.75 " 3.00	2.88	23.2	13.87
6	3.00 " 3.25	3.10	19.2	13.59
7	3.25 " 3.50	3.39	15.9	13.52
8	3.50 " 4.00	3.70	13.4	13.55
9	4.00 " 4.50	4.17	10.0	13.19
10	4.50 " 5.00	4.84	8.3	13.94
11	5.00 " 5.50	5.38	6.7	13.92

The numbers P, the predication averages, and S, the simple sentence percentages, aside from the general reciprocal relation which we should expect, manifest a more specific uniformity. The square-root of 53, the first number under S, multiplied by 1.86, the corresponding number under P, is 13. +, but so also is the square-root of 39.1, the second number under S, multiplied by 2.14, the corresponding number for P. Similarly for the third, fourth, fifth pairs of corresponding numbers. That is, we find

$$1.86\sqrt{53.0} = 13. +$$
$$2.14\sqrt{39.1} = 13. +$$

* 'University (of Nebraska) Studies,' Vol. 2, No. 1.

† For a detailed discussion of this experiment, together with other matter of a more technical nature, see 'University Studies,' University of Nebraska, Vol. III., No. 3.

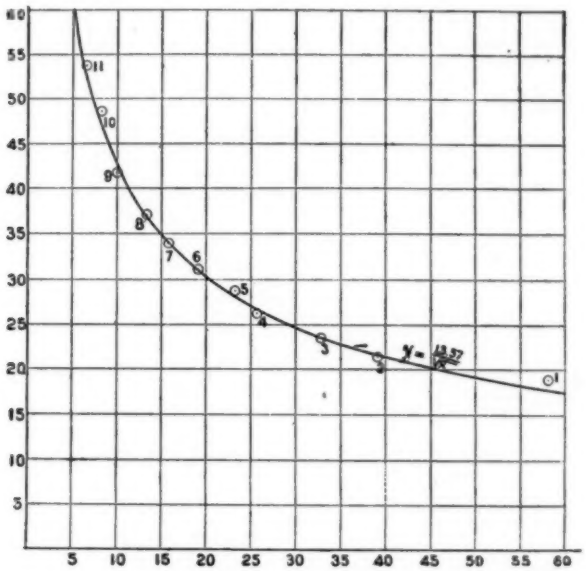
$$2.34\sqrt{32.9} = 13.+$$
$$2.62\sqrt{25.9} = 13.+$$

and so on through the list, the result in each case being 13. +. In short, we have quite uniformly

$$P\sqrt{S} = C,$$

where $C = 13.57$, the arithmetic mean of the slightly varying values 13. +, which are given in the last column of our table.

How nearly this equation fits our data may be best seen from the graphical representation, Fig. 1. The curve $P\sqrt{S} = 13.57$, as well



as the P's and S's from our table, have been plotted in rectangular coordinates by using the values of S for abscissas, and for ordinates ten times the corresponding values of P. The resulting points have been numbered to correspond with the index numbers in our table.

The relation expressed by $P\sqrt{S} = C$ may be easily expressed in words. For if P_1 and P_2 represent two predication averages, and S_1, S_2, the corresponding simple sentence percentages, we have approximately

$$P_1\sqrt{S_1} = C = P_2\sqrt{S_2}$$

from which

$$P_1 : P_2 = \sqrt{S_2} : \sqrt{S_1}$$

that is:

The predication averages of various works are approximately inversely proportional to the square-roots of their simple sentence percentages.

It will be interesting to test this law on some specific work, not included in the table from which the law has been deduced. Macaulay's 'History of England' is the only larger work whose sentence dimensions have been determined with reasonable accuracy. Here S was found to be 34.2, and substituting this in our formula we find

$$P = 13.57 \div \sqrt{34.2} = 2.32$$

which is nearly equal to the value 2.30 as determined by actually counting the finite verbs in 40,000 sentences.

There is, of course, no reason to infer that our formula will apply with equal accuracy to the sentence dimensions of every other work. Variations from it must occur. The only conclusion that is warranted is that when a reasonable number of works are selected whose predication frequency is nearly the same, and the average of these frequencies is taken, this average will bear a definite relation to the average of simple sentence ratios of the same works and that this relation is approximately expressed by our formula.

EDUCATIONAL ENDOWMENTS AT THE SOUTH.

By ELIZABETH M. HOWE.

WITHIN the past five years alone the benefactions to institutions of higher learning in the United States have amounted to a little more than sixty-one millions. That is to say, during that time money from private sources has been devoted to liberal education at the rate of a little more than a million dollars a month. In many cases, it must be admitted, the claim of the institutions thus favored to the rank of college or university is not very substantial, but the gifts themselves represent the loyalty of the donors to a certain ideal of education, however imperfectly that ideal may have expressed itself.

At first it would seem that this flood of gold, the high tide of a stream that began to flow about thirty years ago, could have left no need of the higher education unprovided for; but as usual a closer survey of the field shows not only many a nook not yet irrigated, but whole fields still arid and uncared for. Educational endowments have this in common with other investments, that they follow usually the line of greatest immediate efficiency; they are also controlled in a high degree by sentiment, and the two have so reinforced each other here in America as to turn great streams of wealth in certain directions, while but scanty dribbles have flowed in others. The habit of giving began to establish itself soon after the civil war, and the greatest beneficiaries during these intervening years have been the young men of the New England and north central states. The next most favored class have been the young men and women of the middle states and the west; least of all has the white population of the south profited by this generosity. And by the white population we do not mean the 'poor whites,' nor the mountaineers, nor the 'crackers,' nor any other class traditionally aloof from educational influences, but the white race *in toto*. 'The south,' also, should be defined. For our purpose here it means the ten cis-Mississippi slave states and Louisiana, since the slave states further west have been subjected to influences which have left the first group untouched.

Looking through the list of institutions of the higher learning issued by the Bureau of Education at Washington—a list which is comprehensive rather than critical—we find the advantage in every respect but one with the north. That advantage, to speak politely, is in the number of universities and colleges of liberal arts themselves. Massachu-

setts reports nine and so does Alabama; Rhode Island has one and Connecticut three, but North Carolina has fifteen, Georgia and Virginia each eleven and Tennessee twenty-four. Yet out of a total of 157 millions of productive funds held by American colleges, the south has but fifteen; of eight and a half million books in college libraries, the south holds but one and a quarter millions; the value of her scientific apparatus is a little over a million against a total valuation of seventeen millions, and of grounds and buildings eight and a half millions in a total of 146 millions. The total annual income available for the higher education in Virginia, North and South Carolina, Georgia, Alabama, Mississippi, Louisiana, Tennessee and Kentucky is nineteen thousand dollars less than the yearly income of Harvard University. The efficiency of this income is still further reduced by being divided among a multitude of institutions. Ten feeble colleges are a poor substitute for one strong one. Out of forty institutions in the United States with productive funds amounting to a million and over, but five are in the south; of twenty-one with productive funds of between half a million and a million, but one. As to colleges for women, in 1890 sixty-eight per cent. of all such institutions—classing as colleges institutions empowered to give degrees—were in the south, while seventy-eight per cent. of the endowment of that group of institutions was held by twelve colleges in the North Atlantic states. The increase of endowment for women's colleges since that date has been preponderantly in institutions at the north.

So far as can be gleaned from public records, there are three southern state universities which in thirty years have received no 'benefaction' whatsoever. It is true that in 1878 one of them reported hopefully that it had received some samples of cotton in different stages of growth, and some silk cocoons, but the visions of prosperity thus evoked were not fulfilled. Another term of barren years set in, and though as an emblematic gift—the substance of things hoped for—the cocoons were most happy, as an educational endowment they left much to be desired. Occasionally the southern college not otherwise favored has reported a gift of books, but there has been an ominously large proportion of 'public documents' in these lists, and libraries of country clergymen—hardly treasuries of modern thought, it is to be feared. These facts show another difference, in addition to the quantitative one, between the educational opportunities which have been open to the young men and women of the north and south.

The usual way of meeting an array of facts such as these is to refer to Mark Hopkins on his log as the true measure of the quality of a college, but unfortunately in no way does a scanty endowment tell so against an institution as in securing able teachers. The greatest scholarship, the exceptional ability in teaching, the strong and winning

personality gravitate through urgency of demand to the great centers. Moreover, the abnormal conservatism of the south, both political and religious, creates an atmosphere antagonistic to the finer interests of scholars.

Superficially speaking, liberal training is an unimportant factor in the problem of general education; it is the elementary school that counts. But here again we find a deplorable contrast between the south and other parts of the country. In 1900 the average length of the school year in the southern states was but 109 days, the average expenditure per pupil $9.72. In the north central states—new states, many of them—the average expenditure per pupil was $20.85. We must remember, too, in connection with these statistics, that the border states, such as Maryland and Tennessee, bring up the average enormously. In North Carolina 'school kept' but a fraction over seventy days, and the expenditure per pupil was $4.34. In Alabama, though the school year was eight days longer, the expenditure per pupil was but $3.10, and so small is the enrolment through the southern states, that at the Conference for Education in the South held in 1901, the average number of school days per child was given as three a year. Be it remembered, too, that these children, the men and women of to-morrow, thus on starvation rations scholastically, are without other means to relieve their necessities. There are no 'vacation schools,' no lectures, no libraries, one might almost say no books passing from hand to hand. They are without the stimulus of contact either with active life or with a considerable number of well-educated people; and as they grow to maturity they are too often without occupation, except of the most restricted and uneducative kind. According to Mr. Walter H. Page, the proportion of illiterate white voters in the ten cis-Mississippi southern states is to-day as large as it was in 1850. That is to say, in all these years of marvelous educational development in other parts of the country, and in which even the black, just out of slavery, has so progressed, the southern white has not gained; indeed, he has lost, since he staggers to-day under the incubus of half a century of apathy. We are accustomed to take the 27 per cent. of the census as representing the illiteracy of the old slave states, but that is a very incomplete measure. At least an additional 25 per cent. can do no more than read and write, and the upper level of intellectual equipment and efficiency is below that of the corresponding classes in other parts of the country. Yet upon these men and women devolves the most critical and complicated social problem ever given to a community to solve, one demanding above all else that it be seen clearly and seen whole, and requiring for its solution nothing less than statesmanlike

methods, a wide social philosophy and the finest ethical feeling translated into terms of democracy.

What are the reasons for these lamentable and even tragic conditions? First, certainly, are those so often noted—poverty and a scanty population. The proportions of area and school population might be placed at forty children per square mile in Rhode Island and forty square miles per child in Florida—a condition which gives the former commonwealth an advantage in developing a system of public schools. But back of this and back of the terrible losses of the civil war lies another which has made the first two effective for harm—heretofore the south has not desired any general development of education within her borders. At the time that John Eliot in Massachusetts was praying, 'Lord, for schools everywhere among us,' Governor Berkeley of Virginia, in answer to an inquiry from England, was writing, 'I thank God there are no free schools nor printing presses; God keep us from both.'

William and Mary made a promising beginning. It was established as a school for the Virginia people and the Indians, with an endowment munificent when compared with that of Harvard and Yale at that time. "But," to quote a southern educator, "the idea that education was *not* for the masses did not die an easy death in Virginia; and William and Mary was never a people's school in the sense that Harvard and Yale were. * * * The years following the Revolution saw the defeat of every plan for universal education. Most of the provisions were merely permissive, and the whole atmosphere was antagonistic. The noble plan of Jefferson was too liberal to be even proposed in its entirety, and the part which was made public was so mutilated in the process of adoption that it became an object of contempt."

At the outbreak of the civil war the provision for education below the grade of college was sporadic and infrequent, nor, with the possible exception of the University of Virginia, was there a single college in the south to compare with those of the north. It is necessary to keep these things in mind—the habit of neglect, the established indifference, the educational poverty, both of thought and endowment—if we are to understand the conditions to-day. To those must be added that self-satisfied habit of mind which has always been one of the south's heaviest handicaps. It was with such a history as this that the south had to meet the terrible conditions at the close of the civil war, and it is these traditions which are largely responsible for the tragic mistakes of these later years.

'Why should the children go to school?' asked a South Carolina mother. 'Every one in the county knows who we are.' So the children did not, and to-day are lounging through life in frayed and listless poverty. Even in towns where there was a less open avowal of the doc-

trine that to be known by your neighbors is a liberal education, the attempts at schooling in the later sixties and early seventies presented many picturesque variations from the usual type. The early morning hours would see sedate horses bestridden by from three to five children each making their way into town to deposit their load at a dame school, sometimes a dame school of delicate and antiquated refinement, and sometimes one of a rather hot-handed domesticity, where the boys were cuffed through geography and fractions. These schools sprang usually from the teacher's need instead of from her ability; almost invariably was she without professional training and without educational standards, and too often even without any but the most meager schooling. Such institutions quite deserved the practical disregard in which they were held. Their potent influence—for they exercised one—was not upon the reluctant children within their walls, but upon the community without, for whom they alone represented learning, knowledge, the great society of scholars. It was with such educational standards, perhaps we should say also such educational habits, as these that the generation born just after the war grew up; they knew such schools or none at all; and it was not the child of the poor white alone who depended upon them, but the children of all classes, outside of the chief cities. For many a year after the close of the civil war the shrunken and disheveled libraries lay neglected in the dignified old houses; other cares than those of literature absorbed their owners and their owners' sons and daughters. The *res angustae domi* were studied at first hand, instead of through the medium of Latin authors, and it was full twenty years after, in many cases, before the ruling group of people, even in many of the most favored parts of the south, sent a son to a college of exacting standard and liberal equipment. Their daughters they are hardly sending even now. It is the men and women of that bereft generation, shorn of the family distinction of the past, lacking the discipline of the civil war itself, so royally met by so many southern men and women, and growing up with little or no education who are now in the saddle. Is not this the key to many of the lamentable social conditions in the south to-day? Is the persistent medievalism of thought any but a logical outcome?

In so comprehensive a range of needs it would seem difficult to single out any as specially vital, and it is true that educational endowment for the south can hardly go amiss. But there are certain strategic points which it is especially desirable to gain. The first of these is the development of industrial training. For many a year to come, if not for many a generation, the south must be essentially a rural population, and if the dormant mind is to be reached, it must be through the things with which it is in daily contact. One of the ways to dignify labor is to

make it interesting, and probably no one thing would do more to efface the lingering class distinctions of the south than a well developed and widespread system of industrial education. The man or woman who has skill in your own handicraft commands your respect, no matter who his forebears may have been, and the guild, even though it be unorganized, founded on some form of mental comradeship, is an efficient corrective for many unwholesome class distinctions. Industrial training is also preeminently valuable to the south because it is based on science. To acquire it is to acquire inevitably to some degree the scientific habit of thought, that is to say, the habit of thought which not only demands facts but respects them, and to which law means not the whim of man, but the unrelenting edict of nature with all its inevitable penalties. To displace even an *à priori* theory of how to make hens lay by one based upon an open-minded study of facts, is to make an advance in methods of thinking which must ultimately react upon other things than hens. The calm and impersonal methods of science, once given a foothold, even in the dairy or the poultry yard, must in the end dislodge that impassioned *à priori* reasoning which has been the bane and weakness of the south for so many generations. But the teaching of science is expensive; it means laboratories and experiment stations and provisions for individual work. It means, in short, those endowments in which the south is deficient.

The second strategic need is for the best possible normal training. The lamp of learning, if learning it can be called, has been passed on in one southern hamlet and another from gentlewoman to gentlewoman, who has brought to her work the traditions of culture, the refinement and the care-taking habit which were her birthright. Thirty years ago she was not greatly behind teachers in other parts of the country in professional training—since practically no one had any—but each year since then has put her at a greater comparative disadvantage. Nothing in the history of the south is more promising than the eager desire for professional education which many of its teachers are now showing, and, in so far as they come from the old ruling class, they have the power to confer upon their public a double benefit. A certain condescension towards teachers is apt to linger in the minds of a commercial community, in spite of fervent lip-service. But when the teachers come largely, as they are apt to do in the south, from the class which represents the most deeply rooted traditions of a community, that phase of crudity may be short lived, if not altogether avoided.

The third need of the south is a cordon of secondary schools, financially independent of their patrons. They may be independent as the public school is independent or they may be made so by endowment, but independent they must be, if they are to do their best work. This is an inviting field for endowment, as $100,000 will do for a school what

a million will hardly do for a college. The best solution of the problem of the secondary schools in the south is the concentration of the strength of a community upon its public schools, since to keep them at a creditable level is to help to the solution of more questions than can be reached in any other way. The endowed private school, on the other hand, has the great advantage of being out of politics and having a freer hand in working out its development than is possible to a public school in a community of lax or unformed educational standards. In either case, the point is to secure to the school freedom to select its teachers without political or denominational dictation, and to make it strong enough to impose its standards upon a reluctant community.

Finally, the interdependence of school and college is such that neither can do its best work alone. The college rests upon the school as the house on its foundations, and without the college standards by which to test its work the school loses a powerful stimulus. With the utmost generosity on the part of our philanthropists which can be looked for, even in these lavish days, the southern colleges must remain for many years inferior to those of the north in equipment and as a whole in teaching force. Yet they represent for the great mass of the young men and women in their respective communities the best that is open to them, and, too often, all that can be desired. Probably as valuable a gift as could be made to the south just now, and one requiring a comparatively small fund, would be the establishment of a group of scholarships especially for young southern men and women, available in different institutions in the north. Let us imagine the competitive examinations for such scholarships held at Raleigh for the young men and women of the Old North State, at Columbia, South Carolina, for the students of that state, at Augusta, Jacksonville, Mobile. Not only would every ambitious boy and girl in the state be aroused, but the spur of opportunity would be felt in every school with a spark of life in its management, and there would be the impact upon the very centers of growth of new habits of thought.

'The south has no reason to be ashamed of its traditions,' said a dignified and able southern woman who had done good service for education, when such a plan was broached in her hearing. But by the time that one of her sons had graduated at Harvard and another at Cornell, and her daughter was hard at work at Vassar and her niece at Pratt, she would see that no question of traditions, in the sense in which she felt them threatened, was involved. On the contrary, what is best in the distinctive characteristics of the south can not be preserved by men and women of belated minds, and one of the services which we ask of that part of the country is that those finer elements shall be preserved and made a part of our national life. The present demand for industrial education in the south, too, which is making

itself heard so clearly from so many directions, makes the need of some provision for the best liberal training the more necessary; for unless industrial education is informed and guided by such a spirit, the abyss of a dull utilitarianism awaits it.

The Spanish-American war revealed the south of these later days to itself. It gave—O happy gift!—a new point from which to reckon time, and showed how far, unknown to themselves, the old slave states had moved since Appomattox. A tide of vigor swept through villages and hamlets, bringing them, for the first time in a generation, in contact with the life of the world. It is not fanciful to attribute the educational awakening of the south to-day in part, at least, to that contact with outside affairs—to the sense of oneness with a great nation. But whatever the cause, the fact is here to reckon with—a desire for education throughout the south such as it has never known, and it is being sought in many cases in the face of great difficulties and at the cost of noble sacrifice. Many a southern man and woman, to-day buried in obscure villages, have fairly earned a brevet for gallantry in action in the struggle with stifling social conditions. There is no more present duty for the American people than to uphold their hands. When a community's poverty, born of its ignorance, is such that the tax levy yields but $18 a year for schools, the vicious circle must be broken from outside. The state must care for those hamlets which can not care for themselves, and by a parity of reasoning, the needs of the south are a charge upon public-spirited men and women everywhere. The response should be prompt and abundant. With the new-born desire for education, the line of greatest efficiency for educational endowments is shifted to the south; the need there is great and basal—and they are next of kin.

HERTZIAN WAVE WIRELESS TELEGRAPHY. V.

By Dr. J. A. FLEMING, F.R.S.,
PROFESSOR OF ELECTRICAL ENGINEERING, UNIVERSITY COLLEGE, LONDON.

QUITE recently, Sir Oliver Lodge and Dr. Muirhead have employed as a self-restoring coherer or kumascope a steel disc revolved by clockwork, the edge of which just touches a globule of mercury covered with a thin film of paraffin oil. The contact is made between the mercury and the steel by the electric wave generating an electromotive force in the aerial, sufficient to break through the thin film of oil. When the wave stops, the circuit is again interrupted automatically.

This device is used without a relay to actuate directly a syphon recorder as used in submarine telegraphy. The working battery employed with it must only have an electromotive force of about a tenth of a volt. It may be used also with a telephone in circuit and can therefore be employed either for telegraphic or telephonic reception.*

One of the most sensitive of these self-restoring kumascopes is the carbon-steel-mercury coherer, the invention of which has been attributed to Castelli, a signalman in the Italian Navy,† but also stated on good authority to have been the invention of officers in the Royal Italian Navy, and has therefore been called the Italian Navy Coherer.‡ This instrument has been arranged in several forms, but in the simplest of these it consists of a glass tube, having in it a plug of iron and a plug of arc-lamp carbon, or two plugs of iron with a plug of carbon between them. The plugs of iron, or of iron and carbon, are separated by an exceedingly small globule of mercury, the size of which should be between one and a half and three millimeters. The plugs closing the tube must be capable of movement, one of them by means of a screw, as shown in the diagram (Fig. 17), taken from a patent specification communicated to Mr. Marconi by the

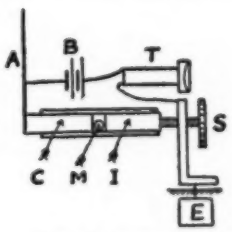


FIG. 17. ITALIAN NAVY SELF-RESTORING KUMASCOPE. *C*, carbon plug; *I*, iron plug; *M*, mercury globule; *A*, aerial; *B*, battery; *T*, telephone; *S*, adjusting screw.

* See *Proc. Roy. Soc. London*, Vol. LXXI., p. 402.

† See Report by Captain Quintino Bonomo, 'Telegrafia senza fili,' Rome, 1902; *L'Elettricista*, Ser. II., Vol. I., pp. 118, 173.

‡ See Royal Institution, Friday evening discourse, by Mr. Marconi, June 13, 1902. Also *The Electrician*, Vol. XLIX., p. 490. Also a letter to the *Times* of July 3, 1902, by the Marchese Luigi Solari.

Marchese Luigi Solari, of the Royal Italian Navy. One of the plugs of this tube is connected to the aerial and the other to the earth, and they are also connected through another circuit composed of a single dry cell and a telephone. The arrangement then forms an extremely sensitive detector of electric waves or of small electromotive forces, or, if a wave falls on the aerial, the electromotive force at once improves the contact between the mercury and the plugs and therefore causes a sudden increase in the current through the telephone, giving rise to a sound; but when the wave ceases, or the electromotive force is withdrawn, the resistance falls back again to its origin value, and the arrangement is therefore self-acting, requiring no tapping or other device for restoring it to receptivity.

A very ingenious form of combined telephone and coherer has been devised by T. Tommasina.* In this instrument the diaphragm of an ordinary Bell telephone carries upon it a very small carbon or metallic coherer. This coherer is connected in between the aerial and the earth, and is also in circuit with a battery and the electromagnet of a telegraphic relay. When this relay operates it closes the circuit of another battery which is placed in series with the telephone coil. The moment the current passes through the telephone coil it attracts, and therefore vibrates, the diaphragm and shakes up the metallic filings. If an observer therefore places the telephone to his ear, he hears a sound corresponding to every train of waves incident upon the aerial. With this arrangement, one can obtain two different kinds of results, according to the nature of the cohering powder placed in the cavity in the diaphragm. First, if the powder consists of a non-magnetic metal, gold, silver, platinum or the like, the receiver will be very sensitive; and at the same time the current passing through it when it is cohered will be sufficient to work a sensitive recording apparatus in series with the telephone coil. Secondly, if the metallic powder placed in the cavity is a magnetic metal, the receiver will be somewhat less sensitive, but will work with more precision, because of the magnetic action of the magnet of the telephone upon the cohering powder. If no recording apparatus is used, the observer must write down the signals as heard in the telephone, since corresponding to a short spark at the transmitting station, a single tick or short sound is heard at the telephone, and corresponding to a series of rapidly successive sparks, a more prolonged sound is heard in the telephone. These two sounds, as already explained, constitute the dot and the dash of the Morse signals.

We may, in the next place, refer to that form of kumascope in which the action of the wave or of electromotive force is not to decrease the resistance of a contact, but to increase that of an imperfect contact. As already mentioned, Professor Branly discovered long ago that

* See U. S. A. Patent Specification, No. 700,161, May 24, 1900.

peroxide of lead acts in an opposite manner to metallic filings, in that when placed in a Branly tube it increases its resistance under the action of an electric spark, instead of decreasing it. Again, Professor Bose has found that fragments of metallic potassium in kerosene oil behave in a similar manner, and that certain varieties of silver, antimony and of arsenic, and a few other metals, have a similar property. Branly tubes, therefore, made with these materials, or any arrangements which act in a similar manner, have been called 'anti-coherers.' The most interesting arrangement which has been called by this name is that of Schäfer.* Schäfer's kumascope is made in the following manner: A very thin film of silver is deposited upon glass and a strip of this silver is scratched across with a diamond, making a fine transverse cut or gap. If the resistance of this divided strip of silver is measured, it will be found not to be infinite, but may have a resistance as low as forty or fifty ohms if the strip is thirty millimeters wide. On examining the cut in the strip with a microscope, it will be found that the edges are ragged and that there are little particles of silver lying about in the gap. If then an electromotive force of three volts or more is put on the two separated parts of the strip, these little particles of silver fly to and fro like the pith balls in a familiar electrical experiment, and they convey electricity across from side to side. Hence a current passes, having a magnitude of a few milliamperes. If, however, the strip is employed as a kumascope and connected at one end to the earth and at the other end to an aerial, when electric waves fall upon the aerial, the electrical oscillations thereby excited seem to have the property of stopping this dance of silver particles and the resistance of the gap is increased several times, but falls again when the wave ceases. If therefore a telephone and battery are connected between two portions of the strip, the variation of this battery current will affect the telephone in accordance with the waves which fall upon the aerial, and the arrangement becomes therefore a wave-detecting device. It is said to have been used in wireless telegraph experiments in Germany up to a distance of ninety-five kilometers.

We must next direct attention to those wave-detecting devices which depend upon magnetization of iron, and here we are able to record recent and most interesting developments. More than seventy years ago, Joseph Henry, in the United States, noticed the effect of an electric spark at a distance upon magnetized needles.† Of recent times, the subject came back into notice through the researches of Professor E. Rutherford,‡ who carried out at Cambridge, England, in 1896, a

* See E. Marx, *Phys. Zeitschrift*, Vol. II., p. 249; *Science Abstracts*, Vol. IV., p. 471. See also German Patent Specification No. 121,663, Class 21a.

† See 'The Scientific Writings of Professor Joseph Henry.'

‡ *Phil. Trans. Roy. Soc. Lond.*, 1897, Vol. 189a, p. 1.

valuable series of experiments on this subject. He found that if a magnetized steel needle or a very small bundle of extremely thin iron wires is magnetized and placed in the interior of a small coil, the ends of which are connected to two long collecting wires, then an electric wave started from a Hertz oscillator at a distance causes an immediate demagnetization of the iron. This demagnetization he detected by means of the movement of the needle of a magnetometer placed near one end of the iron wire. Although Rutherford's wave detector has been much used in scientific research, it was not, in the form in which he used it, a telegraphic instrument, and could not record alphabetic signals.

Not long ago Mr. Marconi invented, however, a telegraphic instrument based upon his discovery that the magnetic hysteresis of iron can be annulled by electric oscillations. In one form, Mr. Marconi's magnetic receiver is constructed as follows* (see Fig. 18): An endless band of thin iron wire composed of several iron wires about No. 36 gauge, arranged in parallel, is made to move slowly round on two pulleys, like the driving belt of a machine. In one part of its path, the wire passes through a glass tube, on which are wound two coils of wire, one a rather short, thick coil, and the other a very fine, long one. The fine, long coil is connected with a telephone, and the shorter coil is connected at one end to the earth and the other to the aerial. Two permanent horseshoe magnets are placed as shown in Fig. 18, with their similar poles together, and, as the iron band passes through their field, a certain length of it is magnetized, and owing to the hysteresis of the material, it retains this magnetism for a short time after it has passed out of the center of the field. If then an electric oscillation, coming down from the aerial, is passed through the shorter coil, it changes the position of the magnetized portion of the iron and, so to speak, brings the magnetized portion of iron back into the position it would have occupied if the iron had had no hysteresis. This action, by varying the magnetic flux through the secondary coil, creates in it an electromotive force which causes a sound to be heard in the telephone connected to it. If at a distant place a single wave or train of waves is started and received by the aerial, this will express itself by making an audible tick in the telephone, and if several groups of closely ad-

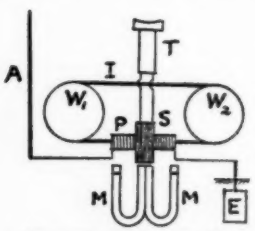


FIG. 18. MARCONI MAGNETIC RECEIVER. W_1, W_2, wheels; *I*, iron wire band *P*, primary coil; *S*, secondary coil; *T*, telephone; *A*, aerial; *E*, earthplate.

* See *Proc. Roy. Soc. Lond.*, June 12, 1902. 'Note on a Magnetic Detector for Electric Waves which can be employed as a Receiver for Space Telegraphy,' by G. Marconi.

jacent wave trains are sent, these will indicate themselves by producing a rapid series of ticks in the telephone, heard as a short continuous noise and taken as equivalent to the Morse *dash*.

It was by means of this remarkably ingenious instrument that Mr. Marconi was able, in the summer of 1902, to detect the waves sent out from Poldhu on the coast of Cornwall, and receive messages as far as Cronstadt in the Baltic, in one direction, and as far as Spezzia in the Mediterranean in another direction, and also to receive messages across the Atlantic from the power stations situated in Glace Bay, Nova Scotia, and from one at Cape Cod in Massachusetts, U. S. A., in December, 1902.

There can be no question that this magnetic detector of Mr. Marconi's, used in connection with a good telephone and an acute human ear, is the most sensitive device yet invented for the detection of electric waves and their utilization in telegraphy without continuous wires. It is marvelously simple, ingenious and yet effective, as a Hertzian wave telegraphic receiver.

Whilst on the subject of magnetic wave detectors, the author may describe experiments that he has been recently making to construct a Hertzian wave detector on the Rutherford principle, which shall be strictly quantitative. All the receivers of the coherer type and electrolytic type give no indications that are at all proportional to the energy of the incident wave. Their indications are more or less accidental and depend upon the manner in which the receiver was last left. There is a great need for a quantitative wave detector, the indications of which shall give us a measure of the energy of the arriving wave. It is only by the possession of such an instrument that we can hope to study properly the sending powers of various transmitters or the efficiency of different forms of aerial or devices by which the wave is produced. This magnetic receiver is constructed as follows:

A coil of fine wire is constructed in sections like the secondary coil of an induction coil, and in the instrument already made, this coil contains thirty or forty thousand turns of wire. In the interior of this coil are placed a number of little bundles of fine iron wire wound round with two coils, a fine wire coil which is a magnetizing coil, and a thicker wire coil which is a demagnetizing coil. These sets of coils are joined up, respectively, in series or in parallel. Then, associated with this form of induction coil is a commutator of a peculiar kind, which performs the following functions when a battery is connected to it and when it is made to revolve by a motor or by clockwork. First, during part of the revolution, the commutator closes the battery circuit and magnetizes the iron cores, and whilst this is taking place the secondary circuit of the induction coil is short-circuited and the galvanometer is disconnected from it. Secondly, the

magnetizing current is stopped, and soon after that the secondary coil is unshortcircuited and connected to the galvanometer, and remains in this condition during the remainder of the revolution. This cycle of operations is repeated at every revolution. If then an electrical oscillation is sent into the demagnetizing coils, and if it continues longer than one revolution of the commutator, it will demagnetize the iron core during that period of time in which the battery is disconnected and the galvanometer connected. The demagnetization of the iron which ensues produces an electromotive force in the secondary coil and causes a deflection of the galvanometer, and this deflection will continue and remain steady if the oscillation persists. Moreover, since this deflection is due to the passage through the galvanometer of a rapid series of discharges, it is large when the oscillations continue for a long time and are powerful, and small when they continue for a short time or are weak. We can, therefore, with this arrangement, receive on the galvanometer, just as on the mirror galvanometer used in submarine cable work, a dot or dash, and, moreover, the magnitude of these deflections is a measure of the energy of the wave.

It is probable that when this arrangement is perfected it will become exceedingly useful for making all kinds of tests and measurements in connection with Hertzian telegraphy, even if it is not sensitive enough to use as a long distance receiver.

Of late years, a variety of wave-detecting devices have been brought forward, which depend upon electrolysis. One of the best known of these is that by De Forest and Smythe.* In this arrangement, a tube contains two small electrodes like plugs, which may be made of tin, silver or nickel, or other metal. The ends of these plugs are flat and separated from each other by about one two-hundredth of an inch. Sometimes the end of one of these plugs is made cup shaped and the cup or recess is filled with a mass of peroxide of lead and glycerine. In the interval between the electrodes is placed an electrolyzable mixture, which consists of glycerine or vaseline mixed with water or alcohol, and a small quantity of litharge and metallic filings. These metallic filings act as secondary electrodes. When a small electromotive force is applied between the terminals of the electrodes of this tube through a very high resistance of twenty or thirty thousand ohms, an exceedingly small current passes through this mixture, and it causes an electrolytic action which results in the production of chains of metallic particles connecting the two electrodes together. If, in addition to this, one terminal or electrode of the arrangement is connected to an aerial wire and the other terminal to the earth, then on the arrival of an electric wave creating oscillations in the wire; these oscillations pass down into the electrolytic cell where they break up the

* See U. S. A. Patent Specification, No. 716,000, Application of July 5, 1901.

chains of metallic particles and thus interrupt the current passing through the telephone quite suddenly, which is heard as a slight tick by an ear applied to it. As soon as the wave ceases, the chain of metallic particles is reestablished, so that the appliance is always in a condition to be affected by a wave. It is said that this breaking up and reformation of the chains of metallic particles is so rapid that a short spark made at the transmitting station is heard as a tick in the telephone, but a rapid succession of oscillatory sparks is heard as a short continuous sound; hence the two signals necessary for alphabetical conversation can be transmitted.

Another receiver which has some resemblance to the above, although different in principle, is that of Neugschwender.* In this arrangement, which to a certain extent resembles the Schäfer detector, a glass plate has upon it a deposit of silver in the form of a strip, which is cut across at one place, thus interrupting it. If the cut is breathed upon or placed in a moist atmosphere, a little dew is deposited upon the glass, which bridges over the cut in the metal and creates an electric continuity. Hence a small current can be passed across the gap and through a telephone by one or two cells of a battery. If, however, an electric oscillation passes across the gap on its way from an aerial to the earth, then the continuity of the liquid film is destroyed and the current is interrupted and a sound created in the telephone.

The opinion has been expressed by Sir Oliver Lodge that in this case the interruption of the circuit which occurs is really due to the coalescence of minute water particles into larger drops, as when vapor is condensed into rain, and hence the continuity of the material is interrupted.

We must then make a brief reference to other kumascopes which depend upon the heating power of an electrical oscillation, which it possesses in common with every other form of electric current. Professor R. A. Fessenden† has constructed a very ingenious thermal receiver in the following manner: An extremely fine platinum wire, about 0.003 of an inch in diameter, is embedded in the middle of a silver wire about one tenth of an inch in diameter, like the wick of a candle. This compound wire is then drawn down until the diameter of the silver wire is only .002 of an inch, and hence the platinum wire in its interior being reduced in the same ratio, will have been drawn to a diameter of 0.00006 of an inch. A short piece of this drawn wire is then bent into a loop and the ends fixed to wires. The tip of the loop is then immersed in nitric acid and dissolved in the silver, leaving an exquisitely fine platinum wire a few hundreds of an inch in

* See *The Electrical Review*, Vol. XLIV., 1899, May 26; *Wied Ann.*, Vol. LXVIII., p. 92; or German Patent Specification, No. 107,843.

† U. S. A. Patent Specification, No. 706,742, 1902.

length and having a resistance of about thirty ohms. This little loop is sealed into a glass bulb like a very small incandescent lamp, or it may be enclosed in a small silver bulb and the air may be exhausted. If an electrical oscillation is sent through this exceedingly fine platinum wire, it heats it and rapidly increases its resistance. The electrical oscillations produced in an aerial are sent through a number of these loops arranged in parallel, and the loops are short-circuited by a telephone, joined in series with a source of very small electromotive force produced by shunting a single cell or opposing to one another two cells of nearly equal electromotive force. Any variation of resistance of the little platinum loops due to the heat produced by the oscillations, by suddenly altering the current flowing through the telephone, will cause a sound to be heard in it. The electrical oscillations when passing through the loops are therefore detected by the heat which they generate in these exquisitely fine platinum wires.

Finally, one word must be said on the subject of electrodynamic receivers, due to the same inventor. An exceedingly small silver ring is suspended by a quartz fiber and has a mirror attached to it in the manner of a galvanometer. This ring is suspended between two coils joined in series, which are placed either in the circuit of the aerial or in the secondary circuit of the small air core transformer inserted between the aerial and the earth. When electrical oscillations travel down the aerial they induce other electrical oscillations in the silver ring, and if the ring is so placed that its normal position is with its plane inclined at an angle of forty-five degrees to the place of the fixed coils, then the ring will be slightly deflected every time an oscillation occurs in the aerial.

Omitting further mention of the details of the kumascopes in use and the receiving aerial, we must next proceed to consider the receiving arrangements taken as a whole.

In the original Marconi system, the sensitive tube or coherer was inserted between the bottom of the receiving aerial and the earth.* Accordingly, when the incident electric wave strikes the receiving aerial and creates in it an oscillatory electromotive force, this last will, if of sufficient amplitude, cause the particles of the coherer to cohere and become conductive. This sudden change from a nearly perfect non-conductivity to a conductive condition is made to act as a switch or relay, closing or completing the circuit of a single cell, and so sending a current through an ordinary telegraphic relay, closing or completing the circuit of a single cell, which may in turn actuate another recording telegraphic instrument, such as a Morse printer. To prevent the oscillations from passing into the relay circuit, small choking

* See British Patent Specification, G. Marconi, No. 12,039, June 2, 1896.

or inductance coils are inserted between the ends of the sensitive tube and the relay and cell and serve to confine the oscillations to the tube.

It has already been pointed out that in the transmiting aerial the amplitude of the potential vibrations increases from the bottom to the top, and when vibrating in its fundamental manner there is a potential node at the earth connection and a potential loop or antinode at the top. The same is true of the receiving aerial. Hence if the kumascope employed is a Branly metallic filings tube and is inserted near the base of the aerial, the difference of potential between its two ends will be small.

It has also been mentioned that a receiver of this type acts in virtue of electromotive force or potential difference, and hence the proper place to insert the coherer is not at the base of the aerial, but between the top of the aerial and the earth. This, however, could not be done by running up another wire from the earth, as that would amount to putting the coherer between the tops of two identical aerials, and between its ends there would be no difference of potential. Professor Slaby, in conjunction with Count von Arco, has given an ingenious solution of this problem. If we take two equal lengths of wire, bent at right angles, and connect the point of intersection with the earth, placing one of these wires vertically and the other horizontally, we then have an arrangement which responds to the impact of electric waves, and has electrical oscillations set up in it in such fashion that the common point of the two wires has a very small amplitude of potential, but the two extremities have equal and large variations. If then we insert a coherer tube between the earth and the outer extremity of the horizontal wire, it is influenced in the same manner as it would be by the potential variations at the top of the vertical wire. In other words, it is acted upon by a large difference of potential instead of a small one. It is not found necessary to stretch the horizontal wire out straight; it may be coiled into a spiral with open turns, and the slight decrease in capacity and increase in inductance resulting from this can be compensated by cutting off a short piece of it.

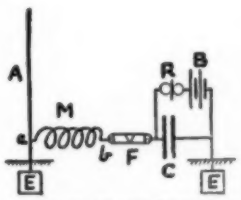


FIG. 19. SLABY RECEIVER. *A*, aerial; *E*, earth plate; *F*, coherer; *M*, multiplier; *C*, condenser; *R*, relay; *B*, battery; *E*, earth plate.

In this way we have an arrangement (see Fig. 19) in which the outer extremity of this open spiral experiences variations of potential which exactly correspond with those at the summit of the vertical aerial. The receiving arrangements are then completed as in Fig. 19, one end of the coherer being attached to the outer end of the spiral and the other end through a condenser to the earth, a relay and a voltaic cell being arranged as shown in the diagram. The mode of operation of this re-

ceiver is as follows: When the wave strikes the aerial it sets up in it electrical oscillations with a potential antinode at the summit, and at the same time a potential antinode is created at the outer end of the spiral attached near the base of the aerial; this spiral being called by Professor Slaby a *multiplicator*. As long as the coherer tube remains non-conductive, the local cell can not send a current through the relay, but, as soon as the resistance is broken down by the impact of a wave, the local cell sends a current through the coherer tube which, passing down to the earth through the base of the aerial and up through the earth connection to the condenser, completes its circuit through the relay. Many variations of this arrangement have been made by Slaby and Von Arco and by the Allgemeine Elektricitäts Gesellschaft of Berlin.

In 1898, Mr. Marconi made a great advance in the construction of his receiving apparatus by the insertion of his 'jigger' or oscillation transformer in the aerial receiving circuit.* In this arrangement, the primary coil of an air core transformer wound in a particular way is inserted between the receiving aerial and the earth, and the secondary circuit is cut in the middle and connected to the two surfaces of a condenser, these surfaces being also connected through the circuit of an ordinary telegraphic relay and a single cell (see Fig. 20). The ends of the secondary circuit of this oscillation transformer are also connected to the terminals of the coherer tube, and these again are short-circuited by a small condenser.

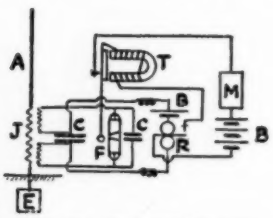


FIG. 20. MARCONI RECEIVER. *A*, aerial; *J*, jigger; *CC*, condensers; *F*, filings tube; *T*, tapper; *R*, relay; *B*, battery; *M*, Morse printer.

The operation of this receiver is as follows: The oscillations set up in the aerial pass through the primary circuit of the jigger, and these induce other oscillations in the secondary circuit; the electromotive force or difference of potential between the primary terminals being transformed up in any desired ratio. It is this exalted electromotive force which is made to act on the coherer tube, and, inasmuch as the jigger operates in virtue of a current passing through its primary circuit and this current is at a maximum at the lower end of the aerial, the arrangement is exceedingly effective, because it, so to speak, converts current into voltage. At the lower end of the aerial, although the amplitude of the potential oscillations is a minimum, the amplitude of the current oscillations is a maximum, and the jigger transforms these large current oscillations into large potential oscillations, *provided it is constructed in the right manner*. We can also transform up or increase the amplitude of the small potential variations near the bottom of the aerial by employing the principle of

* See G. Marconi, British Patent Specification, No. 12,326, of June 1, 1898.

resonance. Many devices of this kind due to Professor Slaby and others have been suggested and tried but the details are rather too technical to be fully described here.

It will be noticed that the receiving aerial may be arranged in one of two ways—it may be either earthed at the lower end or it may be insulated. It has been claimed that there is a great advantage in earthing the receiving aerial directly in that it eliminates atmospheric disturbances.

We shall allude to this point more particularly later on. Meanwhile it may be mentioned that the receiving arrangements, as a whole, constitute a sensitive arrangement, as shown by Popoff, Tommasina and by all the large experience of Mr. Marconi himself for detecting changes in the electrical condition of the atmosphere, which are doubtless of the nature of electrical oscillations. On the other hand, the receiving arrangements may be perfectly insulated, and some experimentalists have asserted that by this method the greatest freedom is secured from atmospheric disturbances. Amongst the non-earthed arrangements the system invented by Professor F. Braun, of Strasburg, and worked by Messrs. Siemens, of Berlin, may be mentioned.*

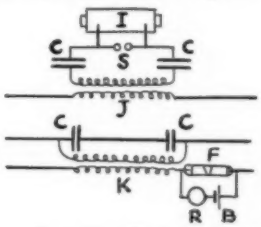


FIG. 21. BRAUN'S NON-EARTHED RECEIVER. *I*, induction coil; *C*, *C*, condensers; *S*, spark gap; *J*, transmitting jigger; *K*, receiving jigger; *F*, filings tube; *R*, relay; *B*, battery.

Professor Braun's arrangements are indicated in the diagram in Fig. 21. In this case, an induction coil is used to create a discharge between two spark balls, and to these two balls are connected the two outer coatings of two condensers, the inner coatings of which are connected together through the primary coil of an air core transformer. The secondary coil of this transformer is connected to two extension wires forming a Hertz resonator, and the length of these wires is so adjusted with reference to the time period of the primary circuit that they resonate to it, the whole length from end to end of the secondary circuit being half a wave length. The receiver, as shown in the diagram, consists of a pair of quarter wave length receiving wires connected through two condensers, which are shortcircuited by the primary coil of an oscillation transformer. The secondary circuit of this last oscillation transformer has two extension wires to it, turned in the same manner, to respond to the primary oscillator; and in the circuit of one of these extension wires is placed a coherer tube, shortcircuited by a relay and a local battery.

It will thus be seen that there is an entire abolition of ground con-

* See *The Electrical Review*, September 26, 1902, Vol. LI., p. 543.

nection, which, Professor Braun claims, practically avoids all atmospheric disturbances.* The details of the receiving arrangement are as follows: The coherer tube consists of an ebonite tube containing hard steel particles of a uniform size, placed in the adjustable space between two polished steel electrodes. It is found that with this steel coherer, a small amount of magnetism in the particles increases its sensitiveness, and to obtain this, a ring magnet is employed in connection with a coherer tube. Receiving apparatus arranged on this system is said to have been used for telegraphing between Heligoland and Cuxhaven, a distance of thirty-six miles.

All the immense experience, however, gained by Mr. Marconi and those who have worked with his system, is in favor of using the earth connection. There is no doubt that Hertzian wave telegraphy can be conducted over short distances by means of totally insulated aerials, but for long distances the earth connection is essential, for the reasons that have been explained previously.

There are many of the details of the receiving arrangements which remain to be considered. If the communication is received by a telegraphic instrument like the Morse printer, which requires a current of anything like ten milliamperes to work it, then an important element in the receiving arrangement is the relay. The relay that is generally used is a modified form of the Siemens polarized relay, which is so adjusted as to make a single contact. For marine work on board ship, it is essential that this relay shall be balanced so that variations in position shall not affect it. Sometimes the relay is hung in gimbals like a compass, and at other times suspended from a support by elastic bands, so as to avoid jolting. In any case, the relay must be so adjusted that no change of position will cause it to close the circuit of the telegraphic printer or recorder. Its sensibility ought to be such that it is actuated by a tenth of a milliampere, and, if possible, even by less. The alteration of sensibility in the ordinary contact form of relay is the pressure that is necessary to bring the platinum points of the circuit closer together, so as to pass the minimum current which will work the telegraph printer.

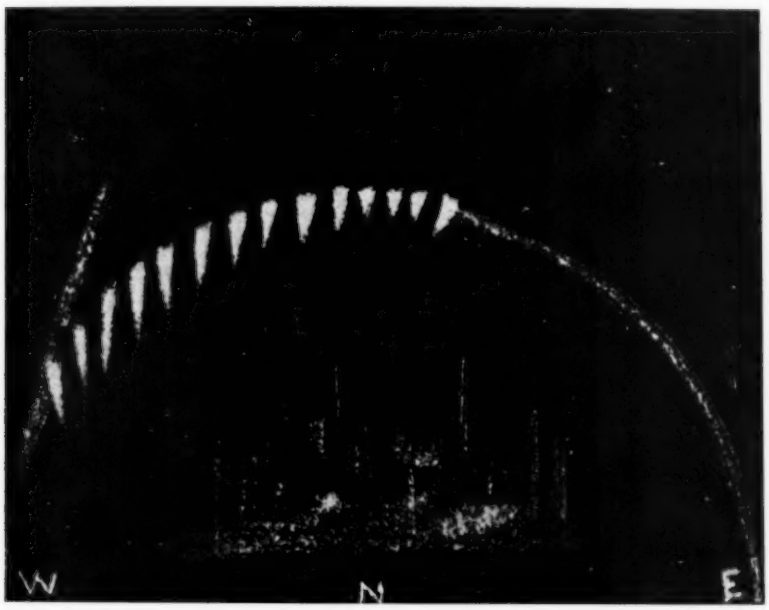
The important matter, however, in connection with the use of the relay in Hertzian wave telegraphy, is that it should be capable of adjustment without extraordinary skill. It is no use to put into the hands of an operator a relay which requires abnormal dexterity to make it work at all.

* There is a good deal of contradiction between various inventors on this point, some saying that 'earthed' aerials obviate atmospheric electrical disturbances, and others that insulated aerials are in this respect superior. The truth appears to be that neither form is absolutely free from risk of disturbance by this cause.

SHORTER ARTICLES AND CORRESPONDENCE.

AN UNUSUAL AURORA BOREALIS.

THERE was one feature of the aurora of August 21, as seen from York Harbor, Maine, of so extraordinary a character as to deserve permanent record. I refer to the arch extending from east to west with its pendant comet-like attachments as shown in the illustration, which last, though unskilfully drawn, gives a fairly correct diagrammatic representation of the phenomenon.



AN UNUSUAL AURORA BOREALIS.

It was a clear starlit night with a low bank of cloud along the northwestern horizon. No moon. The display began between 7 and 8 P.M., with the usual nebulous luminosity in the northern sky with occasional streaks shooting upwards. These gradually became fainter and of but little interest, when, at 9.30 P.M., there appeared a magnificent arch spanning the heavens from east to west, the top of the arch being a little north of the zenith, and almost overhead. As shown in the diagram at least three fourths of the eastern half of the arch consisted of a pale, only half-luminous column of visible streaks, the band being perhaps as wide as the diameter of a full moon appears to be. The western segment of the arch presented a most extraordinary and magnificent spectacle.

Beginning a little east of the zenith and continuing almost to the western horizon, there appeared what might easily be likened to a string of tremendous comets. These pennants of

light, however—unlike comets—were more brilliant at their bases, less so at their apices. Their bases were directed upwards, their points down. They were constantly changing, appearing and disappearing, but not very rapidly. Some would remain a minute or more without much variation. The number varied from ten to fifteen. They were shorter toward the zenith, longer toward the horizon. At the western end of the arch, one long half-luminous streak shot up obliquely (as shown in the figure) and remained for some minutes after the arch itself had disappeared. The arch lasted from 9.30 to nearly 10 P.M.

In size the comet-like pendants appeared about as wide at their bases as the diameter of a full moon, and four or five times such a diameter in length. I reach this estimate by comparing my own conception with those of several others who made observations at the same time.

It should be noted that no visible connection existed between the arch and the nebulous masses and streaks of light near the northern horizon.

In looking at the diagram the reader may well conceive it to be too toy-like and artificial to come within the range of truth or possibility, but so was the arch itself. No one could have conceived such a display to be either natural or possible. To some it suggested a festive arch adorned with luminous cornucopias, like a Christmas decoration. Those of us who a few weeks before had obtained telescopic views of Barelli's comet with some difficulty, seemed now to be rewarded by nature exhibiting a whole string of far more brilliant comets for our special delectation. The kind and degree of luminosity appeared to be almost exactly like that of the comet when seen through a good glass.

The splendor and magnificence of the display were beyond description; startlingly beautiful. The spectacle seemed almost to overstep the modesty of nature, but its coming unheralded during the majestic silence of the night served to banish so unjust a thought. Surprise, delight, admiration and awe—these were the feelings that thrilled with pleasure those of us who witnessed the sublime and mysterious scene—a scene that few of us will ever see again.

The last we saw of this aurora was at midnight when a diffuse light behind a low bank of cloud near the northern horizon gave the appearance as of a moon about to rise. But a medical acquaintance—Dr. S. W. Allen—who was out at 2 A.M. saw shimmering waves of iridescent light streaming radially upwards from the horizon towards a central point at the zenith, a not very unusual phenomenon which many of us have seen once or more during the last half century.

Auroral arches from east to west have been observed in the Arctic regions; double and triple ones are recorded by Mr. E. B. Baldwin in Peary's 'Northward over the Great Ice,' vol. 2, p. 191 *et seq.*, but in this country they are certainly very unusual. Baldwin describes one in which the arch formed itself into a luminous curtain, and the curtain folds knotted 'themselves into a series of electric balls suspended in the same arch-order' (p. 198). These globes of light may have had some approaching resemblance to the comet-like pennants of light I have endeavored to describe.

A. F. A. KING.

SCIENCE AND PHILOSOPHY.

TO THE EDITOR: In the first two paragraphs of Sir Oliver Lodge's admirable address entitled 'Modern Views on Matter,' published in the August number of this journal, he alludes to a distinction between the scientific aspects and the philosophical aspects of his subject and hastens to disclaim any qualifications for discussing the lat-

ter. Thus in the first paragraph he says:

> The nature of matter has been regarded by philosophers from many points of view, but it is not from any philosophic standpoint that I presume in this university to ask you to consider the subject under my guidance.

And in the second paragraph he adds:

> If I may venture to say so, it is the more philosophic side of physics which has always seemed to me the most suitable for study in this university; and although I disclaim any competence for philosophic treatment, in the technical sense, yet I doubt not that the new views, in so far as they turn out to be true views, will have a bearing on the theory of matter in all future writings on philosophy; besides exercising a profound effect on the pure science of physics and chemistry, and perhaps having some influence on certain aspects of biology also.

The course which Sir Oliver followed on the occasion of this Romanes Lecture is not without eminent precedent. Many a man of science has acknowledged subserviency to philosophy on similar occasions; and there is no doubt that the most of us have inherited a belief in the inferiority of science to philosophy. But the question I would ask is whether such subserviency and such belief are any longer justified and hence dignified?

This, of course, raises squarely the question of the distinction between science and philosophy. I assume, however, that it is unnecessary to thrash over old straw here and now. Brushing aside pseudo-science and barren philosophy, what is the distinction, if any, between sound science and sane philosophy?

If one applies the scientific method of investigation to scientists and to philosophers of the modern types he will find, I think, that they are very much alike and that neither claims any superiority over the other. It would appear also that the two words science and philosophy are now very frequently used as synonymous in spite of their widely differing shades of meaning.

Why then should we prolong distinctions which are no longer tenable? Why, to return to the Romanes Lecture, should we be asked to entertain the hypothesis that some Oxford philosopher is more likely to see straight with respect to the intricate properties of matter than Sir Oliver himself? How much, in fact, has all philosophy, in the sense in which Sir Oliver uses the word, contributed to our knowledge of matter? There was a time when every obscure professor of 'moral' or 'mental' philosophy was held, by common consent of the educated, more competent to judge of the philosophic aspects of the 'Origin of Species' than Charles Darwin. But have we not outlived that time, and is not a relapse to the ways of that time, even for the purposes of compliment, reprehensible?

PHYSICIST.

[The point of our correspondent appears to be well taken. But possibly Sir Oliver Lodge's compliment implied that experimental science has been neglected at Oxford.—ED.]

THE PROGRESS OF SCIENCE.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FOR the first time in many years there has been this summer no meeting of the American Association. It will be remembered that the Association held a winter meeting at Washington during convocation week and adjourned to meet at St. Louis a year later. The lack of a summer meeting is in some ways to be regretted. For the presentation of scientific work by specialists to specialists, the most business-like meetings can be held in the winter; but for social intercourse and especially for the bringing of those not specially engaged in scientific work in contact with men of science, a summer meeting with a certain amount of open-air leisure seems to be desirable. Many of our societies continue to meet in the summer, and it seems that the American Association should provide a center. For example, this year the American Mathematical Society met in Boston, the American Chemical Society in Cleveland, the Society for the Promotion of Engineering Education at Niagara Falls, etc. For a general meeting of scientific men, we must, however, turn this summer to the congresses in France, Germany, Great Britain and other foreign countries.

The British Association met at Southport, beginning on September 9, under the presidency of Sir Norman Lockyer, known for his contributions to astronomy and as editor of *Nature*. In the latter capacity, he has been much interested in the endowment of research work, which he treated in the presidential address from which we quote below. In addition to this address evening lectures were given by Dr. Robert Monroe on man as artist and sportsman in the paleolithic period; by Dr. Arthur Roe on the Old Chalk Sea and some of its teachings, and by Dr. J. S. Flett on the volcanic eruptions in the West Indies. Then there were the usual addresses before the sections—Professor W. Noel Hartley, before the section of chemistry, reviewed the work of spectroscopy of the last twenty-five years and discussed especially its relation to the investigation of the composition of matter and of chemical theory; Professor W. W. Watts, before the section of geology, laid special stress on the value of geology as an educational subject; Professor Sydney J. Hickson, before the section of zoology, reviewed the question of the influence of environment in the production of variation in animals with special reference to the cœlenterata; Captain E. W. Creak, before the section of geography, spoke of the connection between geography and terrestrial magnetism, explaining what has latterly been done in the direction of magnetic surveys and what is still needed; the subject of the address of Mr. E. W. Bradbrook before the section of economics was 'Thrift'; Professor J. Symington in addressing the anthropological section discussed the significance of variations in cranial forms with special reference to fossil man; Mr. A. C. Seward, before the section of botany, reviewed the geographical distribution of fossil plants.

The programs of the sections contain the usual number of interesting papers. The International Meteorological Committee met at Southport in conjunction with the association;

the papers included a survey of the relation of solar and terrestrial changes by Sir Norman Lockyer. The new discoveries regarding the constitution of matter and radiation, a scientific advance the far-reaching character of which we can scarcely appreciate, was naturally prominent in the physical section. The papers included one by Professor Rutherford, of Montreal, whose important investigations on the emanations from radium were described by Sir Oliver Lodge in a recent issue of the MONTHLY. The subject chosen for special discussion in the chemical section was 'Combustion.' The geological section conflicted with the International Congress of Geology at Vienna, but the program contained many papers. The subject of 'fertilization' was especially discussed in the zoological section, Professor E. B. Wilson, of Columbia University, being one of those taking part. The British Antarctic Expedition was naturally the subject of special interest to the geographers, while the fiscal questions brought forward by Mr. Chamberlain's proposed abandonment of free trade attracted the economists.

The association will meet next year at Cambridge under the presidency of Mr. Arthur Balfour, the prime minister; the following year the meeting will be in South Africa.

SIR NORMAN LOCKYER ON THE ENDOWMENT OF EDUCATION AND RESEARCH.

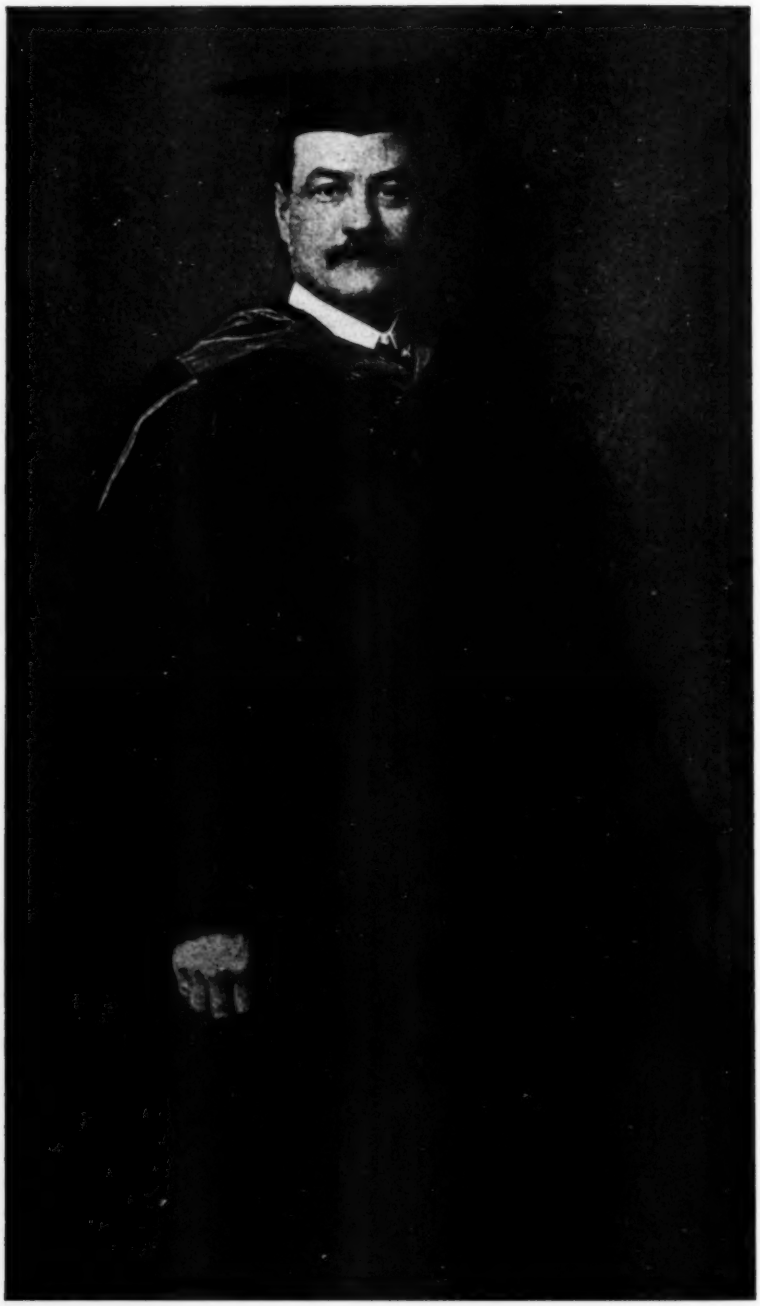
THE presidential address of Sir Norman Lockyer before the British Association was entitled 'The Influence of Brain Power on History.' The speaker laid special stress on the need of greater endowments for higher education and research from the government, and advocated duplicating the Navy estimates of 1888–9, £24,000,000, and devoting that amount to the increase of Great Britain's brain power. He said: Our position as a nation, our success as merchants, are in peril, chiefly—dealing with preventable causes—because of our lack of completely efficient universities and our neglect of research.

What are the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in our country upon this form of endowment we are trusting to a broken reed. If we take the twelve English university colleges, the forerunners of universities unless we are to perish from a lack of knowledge, we find that private effort during sixty years has found less than £1,000,000; that is, £2,000,000 for buildings and £40,000 a year's income. This gives us an average of £166,000 for buildings and £3,300 for yearly income.

What is the scale of private effort we have to compete with in regard to the American universities? In the United States, during the last few years, universities and colleges have received more than £40,000,000 from this source alone; private effort supplied nearly £7,000,000 in the years 1898–1900.

Next consider the amount of state aid to universities afforded in Germany. The buildings of the new University of Strasburg have already cost nearly £1,000,000; that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle and Sheffield. The government's annual endowment of the same German university is more than £49,000.

When we consider the large endowments of university education both in the United States and Germany, it is obvious that state aid only can make any valid competition possible with either. The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other or both of which other nations depend. We are



Nicholas Murray Butler

between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present slough of despond, must be the giving up of the idea of relying upon private effort.

THE SCHOOL OF JOURNALISM OF COLUMBIA UNIVERSITY.

THE endowment of a school of journalism at Columbia University by Mr. J. Pulitzer has been widely discussed by the press, which it so nearly concerns. There is much difference of opinion as to the value of such a school. It is argued that a newspaper man can get his training best in the office of a newspaper, and that the information of the editor, correspondent and reporter is too general and transient to be the subject of a course of study. On the other hand, it is pointed out that in the other professions there has been a transition from the apprentice method to the professional school, and that schools of journalism may become as essential as schools of law or medicine. It is certainly true that the technical equipment of the journalist is less extensive and definite than that of the physician, the lawyer or the engineer. Preparation for journalism seems, however, to parallel pretty closely preparation for the church or for teaching. The divinity student learns Greek, Hebrew, ecclesiastical history, systematic theology and the like, and it is well that he should do so as a matter of training, but the speedy oblivion that usually follows does not decrease the value of his services as a clergyman; on the contrary, the less he concerns himself with the book of Genesis and any definite system of theology the better. It is well for the clergyman to be a scholar, but Horace or the French Revolution will serve as well as the church fathers. The conditions are similar for the intending teacher. He must know the subject that he is to teach, but this is given in the ordinary college and university courses, as are also English, psychology and other subjects that should be studied. The history and principles of education are about as useful for the teacher as ecclesiastical history and systematic theology for the clergyman. A man can not be taught in a school either to preach or to teach. Yet theological schools and normal schools are on the whole useful institutions. Schools of journalism will probably soon be regarded as equally essential.

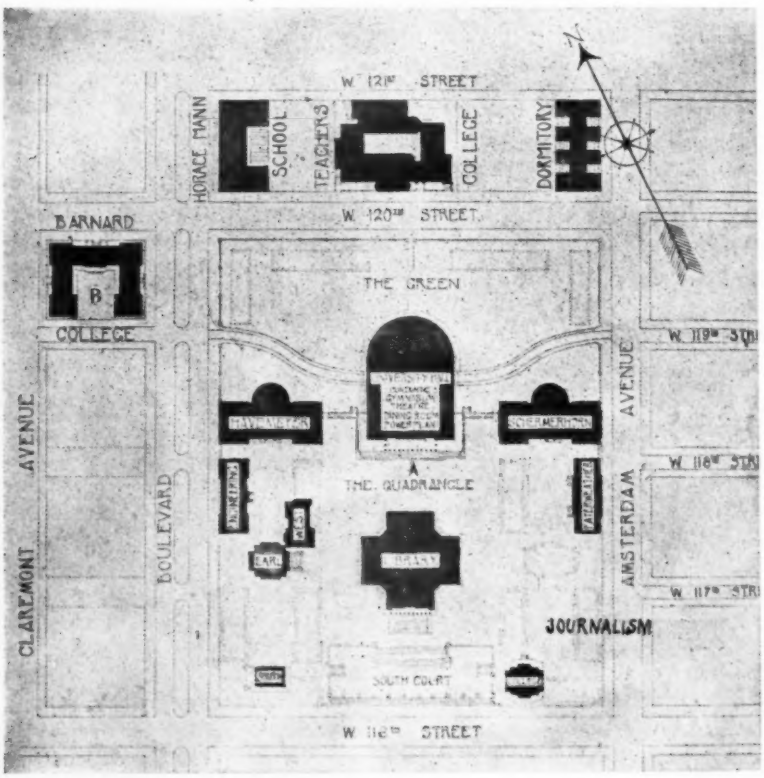
The uses of such schools are partly indirect. They serve for example as selective agencies. Men having talent and ambition frequent such schools, and those quite unfit are eliminated before graduation. Even supposing that four years in an engineering school give no better training than actual work in a shop, still those who graduate from the school are likely to be better men than those who do not—employers run less risk in choosing them. Graduates from the Columbia University School of Journalism will probably deserve advancement better and secure it more easily than those who spend the same years in a newspaper office. The coming together of a large number of men having similar interests and plans tends to encourage and stimulate them. When they form part of a great university, where investigation is continually in progress and high ideals of conduct and culture are maintained, they will insensibly conform to their surroundings.

But there are also certain direct uses of professional schools even in subjects such as teaching, commerce and journalism. The student may pursue the same studies as in the ordinary college course, but the quantity and emphasis are different. The intending journalist should study more English, history and political science than the intending physician, and should study them by somewhat different methods. Then there is a certain

amount of technical information and skill, small in journalism as compared with medicine or engineering, but still deserving treatment in a systematic and broad manner, and more quickly and thoroughly learned in special courses than in actual practice. It is especially the case in a large office that a man has but small opportunity of learning anything except the particular work assigned to him, although it would be for his advantage to know something of the work of other departments. In the case of teachers, summer schools at the universities have proved extremely useful. Similar short courses for journalists will doubtless be given in the new school. The combination of the theoretical study of general principles in a university with practical work under experts is probably the best kind of education for every profession.

Columbia University established the first university school for teachers. This has continually grown in students, in endowments and in efficiency, and has served as a model for other institutions. The school of journalism will doubtless repeat this history. It begins with a generous endowment, Mr. Pulitzer having given a million dollars and having conditionally promised a second million. A building to cost about $500,000 will be erected at once on the site shown in the plan. It will be directly on the right hand of the magnificent entrance to the library here illustrated.

President Butler, whose portrait is reproduced, was elected president of Columbia University on January 6,



PLAN OF THE BUILDINGS AND GROUNDS OF COLUMBIA UNIVERSITY.

ENTRANCE TO THE LIBRARY OF COLUMBIA UNIVERSITY.

1902. In the short period that has elapsed the university has accomplished much, both on the educational and on the material side. In addition to the school of journalism, there have been various other large gifts, including a dormitory costing $300,000. Teachers College is erecting a building for physical education at a cost of over $250,000. Barnard College has been given the three blocks of land shown on the plan south of the college, which cost about $1,000,000; and the trustees of Columbia College have purchased, at a cost of nearly $2,000,000, the two large blocks south of the present site.

THE EMPLOYMENT OF WOMEN.

THE MASSACHUSETTS BUREAU OF STATISTICS has published some rather interesting information in regard to the occupations of the sexes in the state. In 1900 there were 1,208,491 persons engaged in gainful occupations, 72.77 per cent. of whom were men and 27.23 per cent. women. Thirty years before the percentages were 77.87 for men and 22.13 for women. In 1870 the number of females employed in gainful occupations formed 17.03 per cent. of the total number of females of all ages, and in 1900 the percentage rose to 22.88. About one half of all females are under the age of twenty years, and although many of these are employed, there are many above that age who are invalids or the like. It appears that in a very general way it may be said that one third of all women able to work were employed in gainful occupations in 1870 and one half in 1900. Should this increase be maintained, all women able to work would be engaged in earning money one hundred and twenty years hence.

The kind of work is analyzed in the report in great detail, the recapitulation being as follows:

	Males.	Females.	Both Sexes.
THE STATE.	786,454	292,636	1,079,090
Government	17,240	2,846	20,086
Profes-ional	23,845	19,923	43,768
Domestic service	14,782	79,265	94,047
Personal service	25,724	19,762	45,486
Trade	129,875	24,142	154,017
Transportation	69,680	368	70 048
Agriculture	37,281	275	37,556
The Fisheries	8,813	18	8,831
Manufactures	349,546	142,951	492,497
Mining	2,367	—	2,367
Laborers	98,758	207	98,965
Apprentices	5,320	567	5 887
Children at work	3,223	2,312	5,535

It will be noticed that very few women are employed in transportation, agriculture or as laborers. Indeed it seems somewhat remarkable that only 275 women should be engaged in

agriculture, 207 as laborers, 18 in the fisheries and 3 as carpenters. Agriculture and out-of-door labor are the most healthful occupations, and would not affect the health of women, as do the sedentary occupations to which they are especially attracted. There are 15,830 female teachers, 11,357 bookkeepers, 6,412 clerks and copyists and 5,693 stenographers. There were in 1885 only 106 stenographers. Less than three per cent. of the teachers are married and about 5 per cent. of the clerks and bookkeepers.

The compilers of the report abstain from comments on the sociological significance of the figures they give, but they obviously have these in mind as statistics are added as to marriage, birth, death and divorce rates. In 1851, there were about 28 births per thousand of the population; about 23 marriages, and nearly 19 deaths. In 1901, the ratio of births fell to about 25, marriages to about 17, and deaths to nearly 17. There has been an extraordinary increase in the divorce rate, there having been one divorce to thirty-four marriages in 1882, one to twenty-seven in 1891 and one to eighteen in 1901. The decrease in the marriage and birth rates becomes much more significant when it is remembered that the proportion of native-born inhabitants has greatly decreased. In 1882, 55.74 per cent. of those married were native-born, in 1891, only 43.56 per cent. The foreign-born have much larger families, and the birth rate has decreased much more than three per thousand. How far the decrease is due to the increased employment of women in gainful occupations is a question that deserves serious consideration.

SCIENTIFIC ITEMS.

WE note with regret the deaths of Dr. Frederick Law Olmsted, the eminent landscape architect; of Dr. Emmanuel Munk, associate professor of physiology at Berlin, and of Dr. C. K. Hoffman, professor of zoology and comparative anatomy at Harlem.

AMONG honors conferred on American men of science by foreign institutions we notice that Dr. E. C. Pickering, director of the Harvard College Observatory, has been given the doctorate of science by the University of Heidelberg, and Dr. E. B. Wilson, professor of zoology at Columbia University, has been elected a foreign member of the Accademia dei Lincei of Rome.

DR. E. B. COPELAND, instructor in bionomics at Stanford University, has been appointed chief botanist of the United States Philippine Commission. —Dr. William J. Holland, director of the Carnegie Museum of Pittsburg, has returned to the United States with the important paleontological collections of Baron de Briet, which the Carnegie Museum has recently acquired.—Dr. Emil Tietze, director of the Imperial Geological Institute of Austria, was chosen president of the Ninth International Geological Congress, which opened at Vienna on August 20.

THE ship *Terra Nova* has now sailed from England to relieve the *Discovery*. The British government, which has appropriated £45,000 for the expedition, is acting without the advice of the Royal Geographical Society and the Royal Society, which originally sent the expedition, assisted by a grant from the government.

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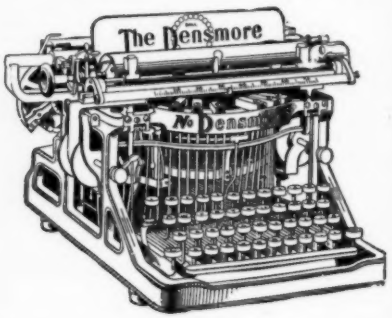

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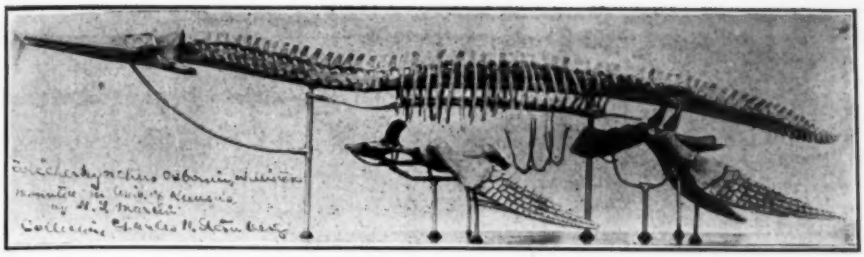

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